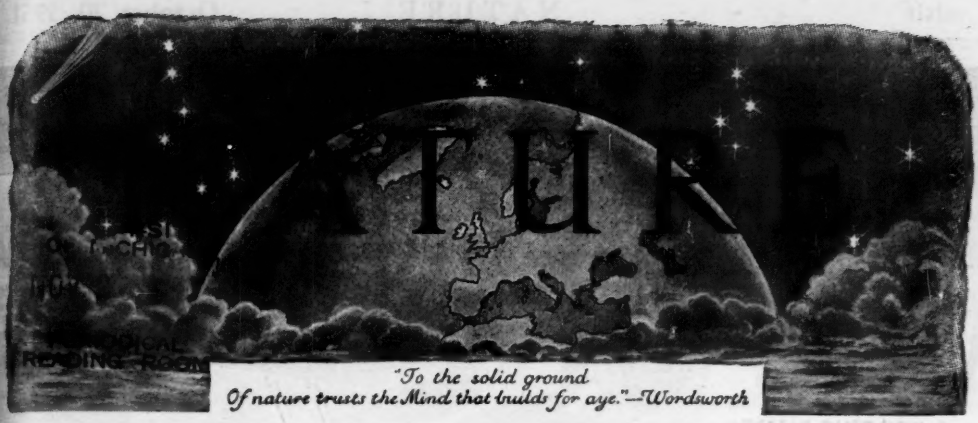

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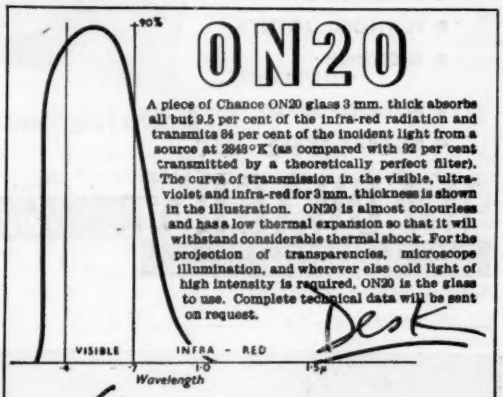

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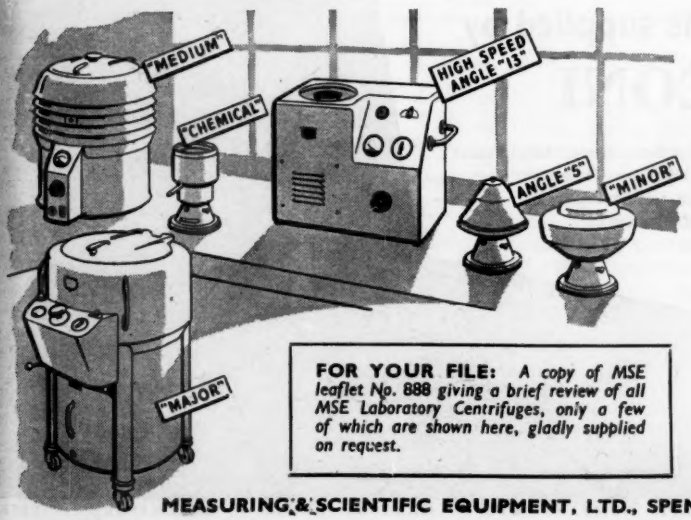

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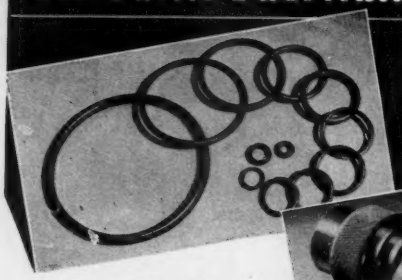

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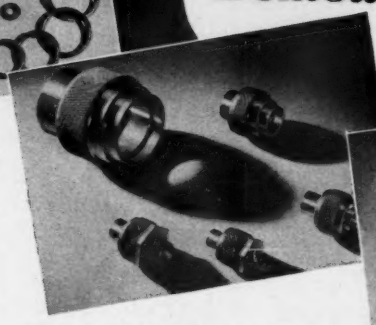

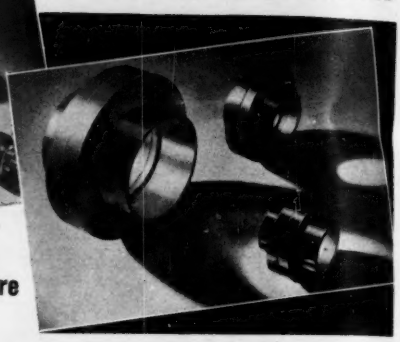

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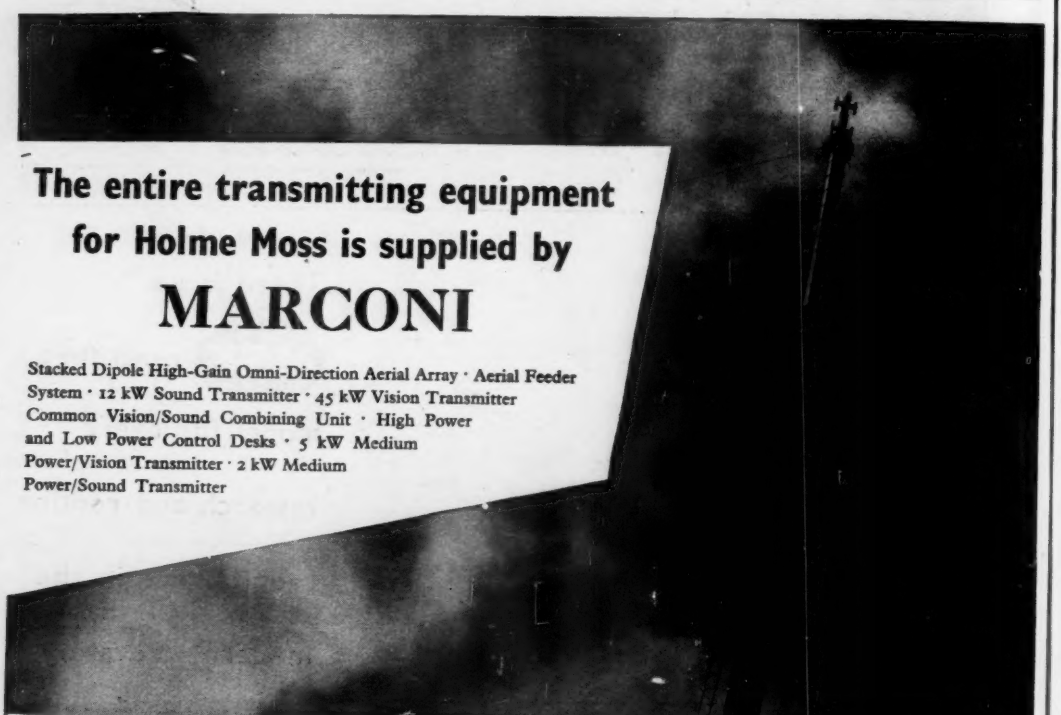

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NATURE

No. 4277 SATURDAY, OCTOBER 20, 1951 Vol. 168

CONTENTS

	Page
Control of Broadcasting in Britain	667
Superconductive Electrodynamics. By Dr. K. Mendelssohn, F.R.S.	670
Impact of Science on Farming	670
The New Foremanship. By T. H. Hawkins	671
Archæological Dating of the Climatic Change in North Europe about A.D. 1300. By Dr. Axel Steensberg	672
The East African Agriculture and Forestry Research Organization. By Dr. B. A. Keen, F.R.S.	674
Unstable Planetary Configurations. By Dr. W. H. Ramsey	676
Obituaries:	
Academician S. I. Vavilov. By Prof. J. D. Bernal, F.R.S.	679
Dr. K. C. Bailey. By Dr. J. H. J. Poole	679
News and Views	680
The 'Lotmar-Picken' X-Ray Diffraction Diagram of Muscle. By Prof. Richard S. Bear and Dr. Cecily M. M. Cannan	684
Movement of Proteins on Filter Paper. By Dr. D. A. Hall and Dr. F. Wewalka; Dr. A. E. Franklin, Prof. J. H. Quastel, F.R.S., and Dr. S. F. Van Straten	685
Annual Exhibition of the Royal Photographic Society, 1951	689
University of Oxford : New Department of Botany	690
Research and Development in British Colonial Territories	691
Letters to the Editors:	
Effect of Irradiation by X-Rays on the Exhalation of Carbon Dioxide by the Mouse.—Prof. G. Hevesy, For.Mem.R.S., and A. Forssberg	692
The Philippine Trench and its Bottom Fauna.—Dr. Anton Fr. Bruun	692
Composition and Structure of Yeast Cell Walls.—A. L. Houwink, D. R. Kreger and P. A. Roelofsen	693
Effects of Ionizing Radiations upon Isolated Deoxyribosenucleoprotein Fibres.—H. M. Rozendaal, W. D. Bellamy and T. H. Baldwin	694
Nature of the Striated Muscle Fibre Membrane.—A. Conte and Dr. P. Riesar	695
Transamination in the Human Tooth.—W. G. Armstrong and H. F. Atkinson	695
Amino-acid Composition of Crotoxin.—Dr. K. H. Slotta and J. Primosigh	696
Tyrosinase and Polyphenoloxidase; the Role of Metallic Ions in Melanogenesis.—Dr. Denis Kertész	697
Fertilizing Capacity of Spermatozoa deposited into the Fallopian Tubes.—Dr. M. C. Chang	697
Birth Coats of Australian Merino Lambs.—P. G. Schinckel	698
Cultivation of Canine Hepatitis Virus in Embryonated Hen's Eggs and its Subsequent Transmission to Dogs.—Dr. J. A. R. Miles, H. B. Parry, Dr. N. M. Larin and H. Platt	699
Rapid Rate of Turnover of Potassium Ions in Kidney Slices.—Dr. R. E. Davies and Dr. A. W. Galston	700
Non-Adaptive Characters in Evolution.—Dr. G. S. Carter	700
The Interglacial Beds at Hoxne, Suffolk.—D. F. W. Baden-Powell	701
Light Filters of Coloured 'Perspex'.—Prof. E. J. King and S. Ventura	702
Solution of Polynomial Equations with the Aid of the Electrolytic Tank.—L. Tasny-Tschiassny and A. G. Doe	702
A Cavity Resonator Method for Electron Concentration in Flames.—Dr. T. M. Sugden and B. A. Thrush	703
A Photo-conductive Effect in Tellurium Film.—W. T. Blackband	704
Stereochemistry of Gold.—R. S. Nyholm	705
Dipole Moments of Aliphatic and Aromatic Amines.—Dr. E. G. Cowley	705
Formula for Creep Curves of Metals.—Prof. Ryukiti Robert Hasiguti and Tosiro Owadano	706

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CONTROL OF BROADCASTING IN BRITAIN

ALTHOUGH the dissolution of Parliament has made the Government's recent Memorandum* on the Report of the Broadcasting Committee of 1949 of somewhat academic interest, whatever government takes office will be required to deal with the broadcasting question as a matter of urgency. The present charter and licence of the British Broadcasting Corporation expire on December 31, 1951, and final decisions on future broadcasting policy cannot be postponed when next Parliament meets. It is apparent both from the Beveridge Committee's report and also from the debates in the House of Lords and in the House of Commons that division of opinion does not run on party lines. Nevertheless, it is vitally important that the significance of the real issues involved should not be lost to sight in the dust of political controversy, and that the decisions should be taken in the light of the fullest possible informed public discussion.

The criticism already expressed of the Report indicates that the debate on the monopoly issue is only just beginning, and that the Beveridge Committee was possibly too timid in considering alternatives to the present system. Because of the urgency of the question and the general trend of discussion, no government is now likely to feel able to do other than extend the present charter on much the same basis, as is proposed in the present Memorandum. In view of the discussion now proceeding on the monopoly issue, as well as the possible technical developments in television and the introduction of very-high-frequency broadcasting, the Memorandum was manifestly right in proposing to renew the charter for a limited period only. The fifteen years suggested seem a reasonable compromise, provided that due regard is had to the fact that certain of the changes recommended by the Beveridge Committee are likely to weaken the administration of the Corporation and, while avoiding abuse of monopoly, make the Corporation inefficient or at least less effective. Moreover, technical developments may offer more promising means of breaking the monopoly or minimizing its inherent dangers.

There are two particular points to be kept in mind. First, during the next fifteen years the danger of ossification in the Corporation is likely to increase. With the passage of time, various areas of B.B.C. activity will lose their novelty and the scope for new ideas will become progressively smaller while the influence of tradition increases. The development of the Home and Overseas Services and now of television cannot indefinitely supply the stimulus they have done during the past two decades. The recommendations of the Beveridge Committee on the administrative side may well accentuate this senescence. This risk requires fuller consideration than is given in the Memorandum.

The second point is that stressed by Prof. John Coatman in an article in the *Journal of Public*

* Broadcasting: Memorandum on the Report of the Broadcasting Committee, 1949. (Cmd. 8291.) Pp. 12. (London: H.M. Stationery Office, 1951.) 6*d*. net.

Administration (29, 160–172; 1951). Prof. Coatman points out that the British Broadcasting Corporation differs from most other public corporations in that its general policy cannot be clearly distinguished from the day-to-day activities which bring it into touch with the public and are the main occasion of criticism. The content of the programmes provokes the bulk of public criticism, and a structure of central responsibility which excludes or ignores such criticism of day-to-day policy is to that extent unreal and unadapted to the situation. To limit public discussion in Parliament in this respect is not in keeping with the nature of the public service which the Corporation provides and, in fact, sells.

Prof. Coatman seeks his solution in an administrative structure on the lines of that of a university. The prototype of the organization Prof. Coatman visualizes is the university with its senate and its council or court. Corresponding with the senate, he suggests, should be a body of high-ranking officials in the B.B.C. charged collectively with similar duties and responsibilities in regard to their work. Major projects such as the inauguration of the Third and Light Programmes, the creation of the board of management and like important matters would be fully discussed by this body, and the governors would be guided by its advice. It would supervise the programme output in respect of quality, technical competence, subject-matter and distribution of time, see to the proper co-ordination of the central and regional programmes, and at the same time eliminate one of the main weaknesses of the existing system, namely, excessive concentration of executive authority at the centre.

The board of governors would correspond with the university council or court, and its relations with the body proposed would be similar to those of the council or court with a university senate. Prof. Coatman suggests further that the board of governors might include a member of the 'senate'. The proposal would ultimately, he suggests, revolutionize the relations between Parliament and the B.B.C., would lighten the responsibility of the Government in respect of broadcasting and would make the B.B.C. a far more democratic and efficient instrument.

There are two conditions, however, which must be served if those purposes are to be achieved, especially if one stresses any analogy between the constitutional position of the B.B.C. and that of the universities in Britain. The first of these is that emphasized by Prof. Coatman himself. Really effective decentralization is essential. Besides broadcasting commissions for Scotland, Wales and Northern Ireland, there would be one or more for England, with functional devolution of television and overseas broadcasting. Really viable units of control would thus be obtained, the activities of which would be co-ordinated in the federal board of governors. Besides this, Prof. Coatman would make either the Lord President of the Council or the Lord Privy Seal responsible for acting for the Government in relation both to Parliament and the B.B.C., apart from matters which, under the Telecommunications Act, fall within the competence of the Postmaster-General. Parliament itself might also appoint an all-party broadcasting committee which would be responsible for keeping in touch with the broad policies and day-to-day activities of the Commissions and the federal B.B.C. board to see that the conditions of the charter are not violated and that the public interests in broadcasting are duly served.

The second condition is that any analogy between the constitutional position of the B.B.C. and that of a university must not be pressed too far. It is purely an administrative matter. The B.B.C. is not and could not be in any sense a university, despite the talk about the Third Programme being 'a university of the air'. Education is only one of the functions of broadcasting. Concern over the maintenance of standards or the elimination of administrative difficulties must not lead us to overlook the fact that the Corporation ultimately must provide what the listener requires. Safeguards against the lowering of standards must not be carried to the point of dictation.

There would appear to be room for much more constructive and fundamental thought on this question of the implications of monopoly and on the maintenance of standards than the recent Memorandum indicates. The first point, about viable units of control, has, however, not been included in the Memorandum. While attaching great importance to the maximum devolution to all areas in programme policy, and recognizing the need for the English regions as well as Scotland, Wales and Northern Ireland to have full opportunities of making their distinctive rich and diversified contribution to the pattern of British life and culture, the administrative implications are apparently not realized. The proposals of the Broadcasting Committee to appoint to the board of governors 'national' representatives, and that there should be 'national' bodies—for which the name 'Broadcasting Councils' is proposed—the primary function of which would be to control the general policy and content of their home programmes, are accepted. In regard to finance and capital development, such Councils would have advisory functions only; but they would be responsible for the appointment of staff wholly employed in connexion with their Home Services.

This is not federation, nor is it decentralization in the sense urged by Prof. Coatman. The idea of 'representation' on the board of governors is in itself objectionable; but the more serious aspect of the proposal in the Memorandum is that such 'national' representatives on the board of governors should themselves each be chairman, not of a commission of five, as suggested by the Beveridge Committee, but of an unpaid broadcasting council drawn mainly from nominees of the county councils and major urban local authorities. The Beveridge Committee did not propose any change in the English Regional Advisory Councils except to increase their independence and knowledge, and thus to strengthen existing programme autonomy of the regional controller; but the Committee recognized that it would be for the proposed national commissions to decide whether or not to appoint such advisory councils in their areas.

The immediate effect of the proposals of the Memorandum would clearly be, first, to destroy the authority of the regional controller and, secondly, to subject the regional programmes to political and sectional pressure. The bodies proposed could not but have a strong local-government and probably party-political trend, and local sectional interests would continually press on the regional controller. Quite rightly the governors of the British Broadcasting Corporation have pointed out that the proposal would for the first time introduce into British broadcasting a system of control into which a political element would be entering. Not only would this be a break with a principle which has been one of the strongest features of the B.B.C., but also it introduces a dual allegiance which itself is liable to endanger standards.

It would be fair to suggest that the Memorandum gives insufficient thought to what is implied by regionalism and to the distinction between separation and the federation advocated by Prof. Coatman. The governors' comment on the proposals indicates that there is real danger that the adoption of such proposals would lead to the fragmentation of British broadcasting and the disappearance of all national programmes. Fortunately, the Memorandum's proposals here, and particularly the selection of broadcasting councils from local authorities, found so little support in Parliament that it was intimated that final decisions would not be taken until Parliament had expressed its views; this should make it easy to drop the whole proposal for regional devolution.

It is to be hoped that the administrative aspect of the proposals will also receive further attention than was apparent in these two debates. While the potential clash of loyalties which might be involved for the B.B.C. staff in devolution was duly noted by several speakers, few apart from Capt. L. P. S. Orr and Mr. A. Wedgwood Benn indicated any appreciation of what was implied financially or administratively. Capt. Orr, quoting from the Beveridge Report that no region could afford by itself to provide a programme service in any way comparable with what is now being achieved by the combined effort of all, rejected devolution accordingly as meaningless without fiscal autonomy. Those who suggested separate corporations for Wales or Scotland did not attempt to meet the difficulty of the limited number of wavelengths available, which was put quite frankly by Mr. Gordon-Walker in opening the debate on July 19.

The problem of decentralization and of the excessive size of the present Corporation was most constructively handled by Mr. Wedgwood Benn, whose suggestion for four boards of management or corporations, responsible for overseas broadcasting, for television, for the Home Service and for the regions, went far towards meeting the need for viable units of control. This was the most constructive suggestion for dealing with this question advanced in either debate, but it is apparent that much more thought is still required in these matters of regionalization and administration before we can secure the steady progress towards greater decentralization, devolution and diversity put forward in the Beveridge Report. Moreover, whatever the immediate decision as to the terms of the new charter, it is important that the utmost care should be taken to ensure that adequate encouragement is given to the development of new scientific methods and processes which might greatly facilitate devolution and decentralization in future.

Mr. C. I. Orr-Ewing directed attention to the possibilities in this direction which the use of very-high-frequency broadcasting may offer. Such possibilities are a matter of finance also, and this is one reason for deploring the Memorandum's proposal to raid the B.B.C. licence fund. It is proposed, with no reason except the ingenious argument that "in present circumstances the B.B.C. should make some contribution to the general revenue", that the Government should take 15 per cent of the net licence revenue for the first three years of the new charter, and that the position should be reconsidered at the end of that time.

This proposal also has brought a strong protest from the governors of the B.B.C., who point out that since January 1, 1947, the B.B.C. has already contributed from its revenues £4,666,330 to meet income tax, and that in the next ten years the proper development of the broadcasting service would tax the Corporation's resources so fully that, if remission of income tax was not obtained, even though 100 per cent of the net licence income was retained, the Corporation would eventually face a deficit of £6,800,000. The Corporation will accordingly, if only 85 per cent of the licence fee is retained, be forced to borrow money which the listener will have, in effect, already contributed. The proposal was heavily attacked in both debates, alike from its effect on technical developments and from the point of view of its essential dishonesty, the implications of which have already been noted in these columns.

There can now be no doubt as to the misgivings with which the proposals of the Memorandum are regarded on all sides, independent of party lines. If no satisfactory scheme of devolution can be devised immediately, it is imperative that the utmost care should be taken to strengthen the regional advisory councils and to promote means of bringing effective criticism to bear upon the hierarchy. Methods adopted for that purpose or to strengthen the position of the governors and make them more effective watchdogs for democracy must not impair the administrative soundness of the organization, or encourage the danger of senescence to which it may well be increasingly exposed. Further, there must be the fullest possible resources available for the exploration of the new technical developments and their implications. It is to be hoped that when official proposals are again forthcoming, they will take fuller account of these matters, that the raid on the licence revenue will be dropped, as well as the threat of introducing political influence into the regional councils; and that whether the charter is renewed for fifteen years or a shorter period, there will be ample opportunity for ensuring that not only are new technical developments explored but also

the means of averting the dangers inherent in a monopoly. Only by careful attention to such matters can we hope that British broadcasting will continue to uphold its high standards and tradition, and to reconcile its function of selling a public service with the maintenance of an unrivalled reputation for integrity and political impartiality.

SUPERCONDUCTIVE ELECTRO-DYNAMICS

Superfluids

Vol. 1: Macroscopic Theory of Superconductivity. By Fritz London. (Structure of Matter Series.) Pp. viii+161. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 40*s*. net.

ALMOST twenty years ago Dr. H. London—then a young research student at the University of Breslau—realized when dealing with the problem of a perfect conductor in an alternating magnetic field that Maxwell's equation $J = \sigma E$ becomes inadequate when $\sigma \to \infty$, since it makes no provision for the inertia of the electrons. Instead he proposed $\dot{J} = (1/\Lambda)E$, where Λ is a new constant which he called "internal specific self-inductance". He thus showed that a magnetic field will enter a superconductor and that the depth of penetration is determined by Λ. In the same year (1933), Becker, Heller and Sauter published a paper in which by considering the problem of a rotating superconductive sphere they arrived independently at the same result.

In 1934, H. London joined his brother, F. London, in Oxford, but in the meantime an important development had taken place—Meissner had discovered the expulsion of a magnetic field from the superconductor. A confused situation had arisen leading to vain attempts at relating the new phenomenon of zero induction with the known fact of zero resistance by means of ordinary electrodynamics. In 1935, F. and H. London provided this link by proposing the new equation, curl $\Delta \dot{J} = -(1/c)H$, which in conjunction with the equation of H. London and Becker has since won general recognition as the fundamental law of superconductive electro-dynamics. In a number of papers F. and H. London have further extended the new electrodynamics, treating various aspects of the subject and providing great stimulus to experimental research. F. London, in particular, has elucidated the quantum-mechanical significance of the theory.

His new book is the first comprehensive summary of the work to be written in English. In 1937 he had written a rather shorter monograph in French[1], and another on the same subject, by M. von Laue, has more recently been published in German[2]. After introductory chapters on the magnetic phenomena and thermodynamics, the equations are introduced and applied to a number of problems. Then their significance is discussed in relation with the assumption of non-viscous flow. The determination of the penetration depth by measurements of the susceptibility and by microwave absorption is described. The next section, dealing with the intermediate state and domain structure, is followed by a discussion of the surface energy between the superconductive and the normal phase and of the transition of thin wires and films. The final section sets out a programme for the molecular theory of superconductivity, and contains the interesting conclusion that in the superconductor it is the momentum vector rather than the current which exhibits long-range order. It is this concept of momentum condensation on which the similarity with liquid helium II, stressed in the introduction, is based.

This clear and rigorous account of a difficult but fascinating subject will be greatly welcomed by all working on superconductivity. One could only wish that the author had been as careful when making historical statements as he has been with regard to the subject-matter. To say that Tisza's two-fluid model of liquid helium (1938) "was not taken seriously enough to be given an experimental test" which had to wait for Kapitza's work in 1941 is quite unjustified, since, in fact, such a test—which yielded a positive result—had been made in Oxford in 1939. The way in which the pioneer work of Becker and co-workers is introduced also does not do full justice to the achievement which it constituted at the time. The analogy between liquid helium and superconductivity has been suggested by others as well, and mention of their work would have detracted nothing from the author's own fundamental contribution. These are, however, very minor blemishes which do not affect the subject-matter of the book. It can certainly be recommended to any research student embarking on the theoretical or experimental study of low-temperature phenomena.

K. MENDELSSOHN

[1] London, F., "Une conception nouvelle de la supra-conductibilité". (Paris: Herman et Cie., 1937.)

[2] Von Laue, M., "Theorie der Supraleitung". (Berlin and Göttingen: Springer, 1949.)

IMPACT OF SCIENCE ON FARMING

The New Farming

By Dr. D. H. Robinson. New edition. Pp. 234+16 plates. (London: Faber and Faber, Ltd., 1951.) 16*s*. net.

THE line between pure and applied science is getting more indistinct, and much of the new knowledge now being used to good effect on the farm is neither simple nor elementary from the scientific point of view. For example, the scouring of cattle on the so-called 'teart' pastures might easily have been ascribed to copper deficiency, and it must be confessed that there was an element of luck in the discovery that it is, in fact, caused by an excess of molybdenum. The solution of the problem presented by the warble fly, or the disentangling of the many sheep diseases, has required much purely scientific work of a very high order. Consequently, a smattering of the elements of a few sciences is no longer sufficient for the agriculturist; he is faced with the task of keeping up with new advances in a number of fields of scientific endeavour.

Dr. D. H. Robinson has set out to simplify this task, and in a little more than two hundred pages he exemplifies the benefits that farming has received from new knowledge. The tale is not, of course, complete. The wider matters of economics and farm management are outside the scope of the book, and in each chapter the method is to pick out the more prominent cases where science has been successful by way of illustration, rather than to cover the subject completely. The examples are skilfully chosen, how-

ever, and together they give a good picture of the impact of science on modern farming, stressing the large contribution that has already been made and indicating the exciting quests which still remain.

It is doubtful if the book would provide a very digestible meal for the non-technical reader; it is very concentrated, and there is no room for explanation of all the terms used. To the agriculturist and to the farmer (in common parlance these two words are not synonymous) it offers a real feast. The chapters on the soil and on crops are sound and satisfying (except for a misprint in regard to the production of sugar in Great Britain), while that on grassland is absorbingly interesting; pests and diseases of crops and livestock, the breeding and feeding of farm animals, herbicides and ensilage are ably discussed. The reviewer started reading the book with some scepticism, doubting whether in such a small compass enough could be included to be useful with sufficient description to make it intelligible. But there is no denying that the aim has been achieved and the reader's interest is held, though that of one reader flagged somewhat over the work of the engineers.

This is not a text-book, although it contains much information. It brings the reader up to date on many questions, impresses on him the importance of science in agriculture and stimulates him to ask for more. It is certainly very easy to read because the English is simple and clear, with a nice economy in words.

THE NEW FOREMANSHIP

The Foreman

A Study of Supervision in British Industry. Undertaken by the National Institute of Industrial Psychology and sponsored by the Human Factors Panel of the Committee on Industrial Productivity. Pp. 158. (London and New York: Staples Press, Ltd., 1951.) 12*s*. 6*d*. net.

As Sir George Schuster says in the foreword, this book deserves notice for three main reasons. First, it is a study of a subject the importance of which is recognized by all who are concerned with the pressing need to increase Britain's industrial productivity. Secondly, the method of investigation —the collection of facts before the elaboration of theories or opinions—is one which is relatively unknown in those sectors of Britain's industrial life which determine the behaviour of men and women. The third merit of the book is that it is one of the projects sponsored by the Human Factors Panel of the Government Committee on Industrial Productivity. It is, in fact, the first comprehensive report to be published on any of these projects, and its contents and presentation augur well for those on joint consultation and other aspects of human relations in industry which are yet to come.

The contents of the book are partly based upon information collected by six investigators over a period of two years. During this time 107 factories were visited, and individual studies of 752 supervisors and their jobs were completed; the report relates to information collected from 87 of the factories and all the individual supervisors. During these investigations a questionnaire covering various aspects of foremanship was sent to some 4,700 establishments employing more than 250 persons, of which 751 returned completed forms. The investigators also devised and carried out trial selection procedures and training courses as well as collaborating with others who were responsible for similar courses. Visits were made to a number of supervisory training courses within firms, in technical colleges and training institutions in Britain and other European countries. In addition, the activities of various foremen's associations, discussion groups and related organizations were observed, while the investigators also made an extensive study of the British and foreign bibliography on foremanship.

It may thus be fairly claimed that the survey has been comprehensive and thorough. But the investigators have not been misled into thinking that their observations have been complete or made into typical cross-sections of British industry. It proved impossible, for example, to arrange for a random sample of firms to be studied, and many of the factories visited were probably above average in several aspects of management policy and practice. Similarly, the foremen seen in each firm probably included too high a proportion of the more able men. For these reasons the investigators readily admit that, almost certainly, the study presents too favourable a picture of existing practice in British industry.

Yet the conclusions will not be without value if they do no more than stimulate discussion on an important subject. They confirm the common belief among thoughtful managers that foremanship to-day requires different skills from those needed in the past; the power of being able to 'sack' has given way to the need for positive leadership based on knowledge, ability and personal qualities. The modern foreman is closely concerned with questions of human relations and administration as well as with his technical and production responsibilities. He must be selected for his capacity to gain the respect, confidence and co-operation of his operatives, colleagues and managers, and he must be trained so that these potentialities will be fulfilled.

Apart from the statistical analyses, much of this book is devoted to the views of the investigators on the status of the supervisor and ways in which he should be selected and trained. Their occupational analysis of supervisory work (on pp. 32–34) is one of the most valuable features of the book, although their prescriptions for selection and training may need revision as further diagnoses are made. In this connexion one of the most practical suggestions put forward by the investigators is the need for a residential centre for supervisory training. For small and medium-sized firms, particularly, such a centre would be of incalculable worth, and it is to be hoped that the sponsors of this investigation will make the necessary approach to industrial and educational organizations and the government departments concerned; a junior version of the administrative staff college is overdue.

The presentation of this survey leaves little to be desired. It is always concise and usually clear; occasionally there is evidence of the efforts of several writers not all of whom have the same gifts for writing or clear thinking. The summaries at the end of each chapter are brief and to the point; the 'review and summary' at the end of the book has been shrewdly prepared so that readers may not forget that the evidence collected and the views put forward by the investigators represent one of the most valuable statements yet prepared on the means of promoting good human relations in British industry.

T. H. Hawkins

ARCHÆOLOGICAL DATING OF THE CLIMATIC CHANGE IN NORTH EUROPE ABOUT A.D. 1300*

By Dr. AXEL STEENSBERG
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IT is a general feature of the agrarian history of northern Europe during the Middle Ages that large-scale colonization of land came to an end late in the thirteenth century, and that in the next two centuries it was followed by the abandonment of hundreds of villages in nearly all parts of north European countries. This phenomenon seems to be connected with a climatic change, and in order to examine the problem briefly it is convenient to separate the sources roughly into two groups: on one hand, the literary records and, on the other, what may be called the scientific evidence.

Among the literary sources one may first mention the hundreds or thousands of notes about the weather of whole years, of seasons or of single days which medieval annalists have included in their historical records. This information has never been studied properly in the full light of modern textual criticism, or with regard to the misconceptions upon which some of them were based. For medieval Denmark, including the lost provinces of Skåne and Holstein, such notes about weather were collected by a doctor of medicine, F. V. Mansa, nearly a hundred years ago[1]. Such data have also been published in the *Scriptores Minores* and *Annales Danici*. For Germany, similar information has been collected by Fritz Curshmann for the period up to 1317[2] and by R. Hennig up to 1800[3]. For Iceland the material has been collected by Dr. S. Thorarinsson, of Reykjavík, and others.

I do not think myself that it is possible to draw any exact scientific conclusions from such imprecise material. The difficulty is, of course, that the records are subjective, and what we find in the annals is almost entirely confined to relative statements. Some few of the official Danish documents do, however, give some information of scientific value which is particularly relevant to this problem. In 1334 they record for the first time that a farm has been left desolate. During the next three or four hundred years this became a general phenomenon in Denmark. The Danish Place-Name Society has recorded the names of hundreds of villages abandoned during the late Middle Ages. They nearly all seem to be names of the type with the termination *-thorp*. In Denmark most of the villages with names terminating in *-thorp* were founded in the early Middle Ages, that is to say, from the tenth to the twelfth century. In one small district of Jutland there are to-day eighteen villages with this name-ending; the Place-Name Society knows of sixteen other *-thorp* villages in this district which were abandoned in the late Middle Ages, and, of course, there may have existed others the names of which have been forgotten.

For Zealand the archivist Svend Aakjær has just published in the *Danish Historical Review* tables which show the decrease in the area of cultivated land from about the middle of the thirteenth until the late fourteenth century. Broadly speaking, the parish tithes of seventy-nine parishes in Zealand declined by about 70 per cent. This retraction of the cultivated land in the late Middle Ages is also well known in England. In 1943 the German scholar W. Abel published his "Die Wüstungen des ausgehenden Mittelalters"[4]. Prof. J. Schreiner, of Norway, has shown that the retraction was a general phenomenon throughout northern Europe[5], whereas we know from other sources that the agriculture of Italy was flourishing in the fifteenth century. Everywhere in northern Europe the retraction was connected with a fall in the prices of corn and with a falling population. Prof. Schreiner has shown clearly that corn prices fell from about 1300, whereas it was not until 1348 that the pestilence known as the Black Death first broke out. The English records of the output of corn from year to year, which are preserved for some abbeys and manors throughout the Middle Ages, do not show any decline of output starting anywhere around 1300, but this may be due to the fact that all the land to which the English records relate had been tilled and cultivated intensively from Saxon times or even longer. Such well-tilled land with a big content of humus is not very sensitive to an increase in the wetness of the climate. A change from less to more rainfall would first hit marginal lands recently brought into cultivation, which commonly lack humus in their raw clay and sands and which are therefore the first to be affected by climatic changes.

All this, however, only shows that there is nothing inconsistent between an unchanged record of corn output and a climatic deterioration. It does not prove that such a change occurred; and, indeed, the historical sources clearly cannot themselves provide any such proof.

Recently Dr. S. Thorarinsson, in his work "Tefrokronologiska Studier", has tried to date the layers of ash from the volcanoes of Iceland, and seems to have been completely successful[6]. It has been possible to fix the layers of the big eruption of Hekla to the year 1300. It seems clear that in Iceland a climatic change at about this time brought corn-growing to a gradual end. Pollen analysis has shown that corn-growing started in Iceland when settlers occupied the country in the Viking period; in particular, they grew barley and also some oats. Corn-growing had not quite stopped in the year 1300 when Hekla had its great eruption, the ashes of which can be discerned in the bog strata. It cannot be argued that corn-growing stopped merely because importation became easier as a result of trading with the Hanseatic League in the late Middle Ages, for, until modern times, Iceland never had better intercourse with foreign countries than during the tenth century, when corn-growing reached its maximum. Dr. Thorarinsson has also shown that the glaciers of Iceland advanced from the late Middle Ages until they reached a maximum about the year 1700. Since 1850 they have been retreating again, and it is now again possible to grow some corn in the country.

Franz Firbas and others have investigated the history of the vegetation in the Alps of Central Europe. In his "Untersuchungen über die Entstehung der heutigen Waldstufen in den Sudeten" (1949) he mentions that woods with abundant beech trees covered the Riesengebirge right up to the ridges of

* Substance of a paper read on August 14 at Edinburgh before Section H (Anthropology and Archæology) of the British Association.

the mountains at least until the beginning of the fourteenth century[7]. From the fourteenth to the seventeenth centuries the upper tree-line lay 100–200 m. lower than either before or after. In the western Alps also, the glaciers advanced from about 1300 onwards, but they retreated again during the fifteenth century; a new advance began about 1600. When, however, Brooks in his "Climate through the Ages" correlates these changes with the climatic history of Iceland, he is probably making a mistake. Thorarinsson mentions that in Iceland there was also a glacial advance in the sixteenth century and beyond, lasting until the mid-seventeenth century or even into the mid-eighteenth century.

Before going on to discuss recent Danish investigations, mention must be made of the underground water which seems to have caused great difficulties in the silver mines of Central Europe in the years after 1300. The production of silver fell throughout Europe and caused a great shortage in England as well as in other countries. Of the Goslar mines in Germany, it is stated that in 1360 the water in the mines had been increasing for more than fifty years and that all attempts to improve the conditions had been in vain. Just after 1400 it is recorded that a new but unsuccessful attempt was made to resume production at the Rammelsberg mines. In Freiberg an attempt was made in 1365 to introduce a hoisting apparatus for getting rid of water, and a further unsuccessful attempt was made in 1379. In Bohemia the same problems arose in 1315 at Iglau, and the mines of Dutchbrod were abandoned as early as 1321. At Kuttenberg the use of mechanical drainage was started in the second half of the fourteenth century; but it was not until the Fugger merchants made extensive investments in the mines and in mining equipment in the late fifteenth century that silver production of Central Europe overcame the difficulty of excessive water[5]. These difficulties with water in the mines, starting as they do soon after 1300, provide a practical demonstration of the climatic change implied by the advance of the glaciers.

The best proofs of the reality of the change, however, will, I think, be found in the bogs and in the desolated villages of northern Europe. The Swedish pollen-analysis expert, Erik Granlund, published in 1931 his first observations on the so-called recurrence-surface No. 1 (the *RY* I), which he dated roughly to about A.D. 1200[8]. These recurrence surfaces represent renewals of the growth of sphagnum in the bogs concerned, and like the well-known *Grenzhorizont* (designated *RY* III in Granlund's terminology) probably represent a relative increase of atmospheric wetness compared with the period which the surface terminates.

In 1943 Valdemar Mikkelsen, of Copenhagen, demonstrated the existence of such recurrence surfaces in five Jutland bogs, and in his work on Præstø Fiord in 1949 he advanced the thesis that the climatic change at *RY* I is characterized by the rise of the beech curve in the pollen diagrams and by the occurrence of *Centaurea cyanus*, the cornflower[9]. Cornflowers had not been identified in Denmark since the Late Glacial Period apart from one or two dubious finds from the Iron Ages. But from *RY* I Mikkelsen has now counted nearly forty grains. This is an exceptionally large number because the pollen grains of *cyanus* are spread only by the aid of bees and other insects, not by the wind, as in the case of a great many other pollen grains.

Dr. Hagbart Jonassen has also recorded the existence of the *RY* I[10]. In some diagrams of Jutland bogs which have been published in his work "Recent Pollen Sedimentation and Jutland Heath Diagrams" (1950), in each case the beech curve is rising just at *RY* I, but he has not noticed *Centaurea cyanus* because the sections which he has investigated lie in uncultivated areas in the Jutish heaths. Prof. Knud Jessen, in his work on the Late Quaternary deposits and flora history of Ireland published in 1949, states that there are similar recurrence surfaces in that country. So far, however, it has not been possible to assign exact dates to these surfaces. Even Granlund's date of about 1200 for *RY* I is very vague and problematical.

Dr. Mikkelsen and I think that we can now date *RY* I more exactly. I happened to carry out an excavation in an abandoned village named Bolle, in Vendsyssel, the northern promontory of Jutland. This village was not one which had been abandoned in the Middle Ages but had survived until 1650, when it was abandoned in order to create a manor. The most interesting archæological discovery was the dam of a water-mill dated at the turn of the last century B.C. and the first A.D. I was excavating this site with interruptions during 1939–48. During the last season Dr. Mikkelsen and I carried out large-scale investigations into the stratigraphy and pollen distribution of the site.

The mill-pond was not, of course, made in a sphagnum bog, and it was therefore impossible to find the *RY* I itself. We did, however, find the fluctuations of the beech curve which we knew from so many other localities both in Jutland and on Zealand, and moreover the *Centaurea cyanus* started just where the beech curve was rising for the last time.

It was, however, the dating of this phenomenon which we wanted to know. Fortunately, during one of the first years of my excavation at Bolle, I happened to find a hearth on which iron ore had been reduced to iron, and among the layers of charcoal and slag I found some potsherds which could be dated with certainty to not earlier than 1250 and not later than 1325–50. I had been cautious enough only to destroy one-half of this hearth, and I remembered that it had been stratified with peat both above and beneath it; we therefore dug a section from the hearth out into the middle of the bog and took pollen samples from both ends. Dr. Mikkelsen was not able to let me have the pollen spectra and his commentaries at the time of writing this article; but he is just finishing his report, and this will appear within a year in publications of the National Museum. It will show that the bog at Bolle was dry from about the Viking period or the very early Middle Ages just up to the time of the dated finds, which can now be assigned to about A.D. 1300. It is exactly at this level that the *Centaurea cyanus* starts and the beech curve rises.

One naturally seeks for an explanation of these two characteristics. The increase of beech pollen need not indicate that the beech-forest has actually been recovering because the climate has become wetter. Dr. Johannes Iversen has suggested that the increase may be no more than a relative one, expressing the fact that other tree species, the pollen of which were formerly represented in the bog, had by this time disappeared.

The phenomenon of the appearance of the cornflower is connected in some way with the cultivation

of ordinary wheat. Nowadays the cornflower flourishes chiefly in wheat fields which have suffered much from winter frost. As yet, we do not know much about the kinds of wheat grown in Denmark during the Middle Ages. Mr. Hans Helbæk has studied grain impressions on potsherds and carbonized cereals in England, Ireland, Holland and Denmark, and he is now working on the rich Swedish material from Vallhagar in Gotland. In his book on grain impressions from English potsherds, published by the Royal Danish Society of Science in 1944, he and Prof. Jessen state that most of what popularly is called wheat from earlier periods in England is in reality naked or hulled barley, emmer (that is, *Triticum dicoccum*) or small spelt (*Triticum monococcum*)[11].

Ten years ago, when I was excavating some farm-sites in the village of Hejninge, near Slagelse in Zealand, I happened to find a heap of carbonized grain on a floor which could be dated by coins to between A.D. 1300 and 1500. Last year, when I was excavating the medieval levels of some farm-houses in Store Valby, also near Slagelse, I happened to find in a post hole some carbonized barley with a small piece of rye bread. This post hole had been covered by a fireplace layer within which was a coin, by means of which the grain and the bread could be dated to not later than about 1400, and potsherds in the floor to which the post hole belonged indicated a date for the finds of not much earlier than 1300.

This find led me to investigate every spot of black earth containing any sort of carbonized material which could be dated by means of potsherds or coins. I took Mr. Helbæk down to the site, and immediately he discovered single grains and seeds in other black spots. After this I took all this material back to the laboratory. Mr. Helbæk made a washing device to make it easy to divide the grains and seeds from the earth and dust, and he has made a number of interesting new finds which he expects to publish. Mr. Helbæk and I hope that it will soon be possible to reconstruct a generalized sequence of plants and seeds for the Middle Ages as it has already been possible to do for the prehistoric times. It will remain, however, very important that sites of villages which have been abandoned in the late Middle Ages should be excavated so that information on the mixture of corn and wild seeds in such places may be obtained. I am at present surveying the fields of such a village in Zealand, and I shall try to find the site by means of analysis of the phosphoric acid content. I am sure that the knowledge gained from such investigations, together with advances in the other fields of inquiry which I have mentioned, will yield much more exact information than has been available hitherto about the true character of the climatic change which we can be certain took place round about A.D. 1300.

[1] *Bidrag til Folkesygdommenes og Sundhedspleiens Historie i Danmark* (Copenhagen, 1873).
[2] "Hungersnöte im Mittelalter", *Leipziger Studien aus dem Gebiet der Geschichte*, **6**, 1 (1900).
[3] Katalog bemerkungswerter Witterungsereignisse, *Abh. der Kgl. Preuss. Meterol. Inst.*, **2**, 4 (1904).
[4] "Quellen und Forschungen zur Agrargeschichte", **1** (Jena, 1943).
[5] "Pest og prisfall i senmiddelalderen", *Norske videnskaps-akademi i Oslo*, **2**, Hist.-filos. klasse 1948, No. 1.
[6] Copenhagen, 1944. Also *Geografiska Annaler* (Stockholm, 1944).
[7] *Planta*, **36** (1949).
[8] Granlund, Sveriges geolog. undersöknings årsbok 1931 ; De svenska högmossernas geologi, Årsbok, **26** (Stockholm, 1932).
[9] *Res. Botanicæ Danicæ*, **13**, No. 5 (1949).
[10] *Res. Botanicæ Danicæ*, **13**, No. 7 (1950).
Kgl. danske vidensk. selskab, Biol. skrif., **3**, 2 (Copenhagen, 1944).

THE EAST AFRICAN AGRICULTURE AND FORESTRY RESEARCH ORGANIZATION

By Dr. B. A. KEEN, F.R.S.
Director

THE headquarters and laboratories of the East African Agriculture and Forestry Research Organization at Kikuyu, Kenya, formally opened by the Right Hon. James Griffiths, Secretary of State for the Colonies, during his recent visit to East Africa, were built with money provided from the research allocation of the funds made available by the Colonial Development and Welfare Acts. Although neither the initiation nor the stimulation of research into Colonial problems are new ideas in British Colonial policy—the work of the Imperial Institute and of the short-lived Empire Marketing Board affords evidence of this—the idea of regional research organizations serving a group of contiguous Colonies is a relatively new conception. The British Colonies lend themselves to this idea, forming such obvious groups as Malaya, West, East, and Central Africa, and the West Indies. The Colonies within a group have many common problems, and it is obviously more efficient and more economical of men and money to conduct on a regional basis the researches required.

The machinery for regional research into agricultural problems of both arable and animal husbandry has so far been most fully developed in East Africa. Although still short of staff, and handicapped by swiftly rising costs, the East African Agriculture and Forestry Research Organization is now functioning in its new headquarters and laboratories at Muguga near Nairobi. A sister organization, the East African Veterinary Research Organization, will share some of these new facilities, and is also in process of developing others for research into animal diseases on an adjoining site. The initial development of the Agriculture and Forestry Research Organization was greatly helped because it absorbed the staff of the East African Agricultural Research Institute established in 1927 at Amani in Tanganyika Territory, and certain new appointments could be housed there pending the completion of the new centre at Muguga.

The Colonial Development and Welfare scheme setting up the Agriculture and Forestry Research Organization was approved in February 1948. It was based on the conclusions of two East African conferences, held in 1946 and 1947, and on the recommendations of the director of the Organization, who had been appointed earlier in 1947, so that he could go into the matter on the spot. Two subsidiary schemes, one for the study of fertilizer responses in East Africa, and the other for the study of the serious 'sudden-death' and 'die-back' diseases of cloves in Zanzibar, were also set up earlier on grounds of urgency ; the scientific staff for these was drawn from Amani, and the Agriculture and Forestry Research Organization scheme was designed to re-absorb them on the expiry of the subsidiary schemes.

Amani was quite unsuitable for development because of its isolation and very steep slopes ; nevertheless, the decision to build near Nairobi, because of its central position and accessibility, would have been a costly one, but for the generous action of the Kenya Government in presenting an admirable site of 1,600 acres in the Muguga Forest Reserve, close to Nairobi and accessible in all weathers.

The Colonial Development and Welfare scheme for the Organization is based on a research staff of forty-five at the end of 1957; the intention was to reach thirty-five by the end of 1952, plus the appropriate administrative and scientific-assistant posts. Steeply rising costs have imposed changes in the original scheme. Thus, although the capital expenditure has been increased over the original amount, it cannot provide all the house and hostel accommodation needed, even for the scientific and administrative staff envisaged at the end of 1952. The buildings for administration, and for various common services that are discussed later, will serve adequately for the full original scheme; the laboratory accommodation is, however, insufficient for this, even allowing for some overcrowding. Rising costs have also affected the recurrent part of the scheme, and it will be very difficult to sustain even the establishment of thirty-five research officers; this number has been agreed on as the minimum required for a properly balanced research programme.

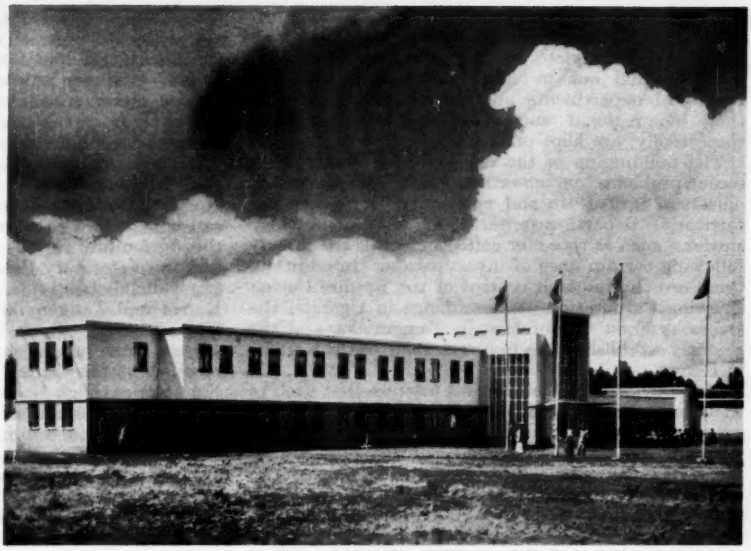

Photo: East African Railways and Harbours, P.O. Box 79, Nairobi

Headquarters building of the East African Agriculture and Forestry Research Organization

The capital grant was £296,000, and was wholly provided by the British Government. One-half of the recurrent costs is also provided from home, and the remaining half is shared in equal proportions by Kenya, Tanganyika and Uganda; Zanzibar also provides a small contribution. The budget for 1951 was about £80,000, so the share of any one territory was less than £14,000.

More than 54 per cent of the capital grant of £296,000 had to be spent on housing and site development items, such as access roads, boreholes, sewage and drainage; in Britain, the great bulk of the cost of these items would not have been incurred. The direct capital expenditure on the Research Organization was as follows:

Laboratories	£34,300
Library	13,000
Administration and offices	21,100
Site works for above	4,700
Workshops and stores	5,200
Equipment	42,300
Animal husbandry (under construction)	14,300
	£134,900

A considerable part of this capital expenditure has been incurred not for the Agriculture and Forestry Research Organization, but for the East African Veterinary Research Organization, in accordance with the declared policy of effecting the closest integration of these two research organizations in all matters of common interest. Thus, there is a joint Division of Animal Husbandry; the library, workshop and services will be common; the General Analysis and the Statistical Sections, although staffed by the Agriculture and Forestry Research Organization, will serve both organizations; one-quarter of the laboratories are for the use of the Veterinary Research Organization; and the administrative offices of both organizations are under the same roof. The administration block also includes, besides offices, the following items: Bureau for Epizootic Diseases; Forestry Bureau; librarian's room, book-binding and library service room, and stack room; rooms for the head of the joint Animal Husbandry Division; the Statistical Section of the Agriculture and Forestry Research Organization; and, finally, a large conference room and ante-room. The laboratories are in three single-story blocks, and there is ample space on the axial line of each block for the orderly placing of auxiliary buildings such as pot-culture and greenhouses. Each block consists of six laboratories, 15 ft. × 20 ft., on one side of the corridor; on the other side there are six ancillary laboratories, each 15 ft. × 12 ft., a number of which are subdivided into rooms 7½ ft. × 12 ft., which is a convenient size for balance, washing-up, photographic rooms, etc. The possibility of future re-arrangement was borne in mind, and the laboratory blocks were so designed that none of the transverse walls is weight-bearing. Bench design follows modern practice, with bench legs and laboratory fittings in steel and of unit-design. Substantial economies over the cost of imported bench tops were made by constructing them locally from Mvule (*Chlorophora excelsa*) obtained from the Amani plantations, and by making floor-blocks from the waste pieces. The windows are of plate-glass louvres which provide adjustable ventilation and avoid the casting of inconvenient shadows from window-bars. As the station is nearly on the equator the axial line of the laboratories runs east to west, and further shielding from direct sunlight at varying seasons and times of day is provided by horizontal hoods projecting beyond the windows, and vertical fins between them.

The library has a 6,000-ft. run of shelves, with a maximum shelf height of 7 ft., so that no book is beyond arm's reach. Four study-cubicles have also been provided for the use of those writing reports or theses.

The research programme of the East African Agriculture and Forestry Research Organization, although at present incomplete because of staff shortages, is being worked out in close consultation with the territorial departments and the Colonial Office, so that the regional and Colonial Empire aspects, respectively, are kept under review.

The building-up of the regional programme offers some problems in co-ordination. The specialist officers of agriculture and veterinary services in the territorial departments, and in the 'commodity stations' such as those for coffee and sisal, are already following certain lines of investigation. In addition, there are the research centres of the Empire Cotton Growing Corporation at Namulonge in Uganda, the Overseas Food Corporation in Tanganyika and the recently established Tea Research Institute at Kericho in Kenya.

It is obviously to the general interest that each of these organizations should, when drawing up its own programme, be fully aware of what the others have in mind, and that there should be every opportunity for discussions, especially between those engaged on similar lines of work in different centres. It is, or should be, equally obvious that, in the laudable attempt to secure 'co-ordination of effort and prevention of overlapping'—to use a heavily over-worked phrase—there is much danger of elaborating the administrative organization at the expense of flexibility and freedom of the scientific work. This tendency is likely to arise in regions such as East Africa, where each Colony has its own departments of agriculture, veterinary services and forestry, and where the regional research organizations come under the East Africa High Commission; it may lead, for example, to a particular scientific committee being three or four times larger than necessary or, alternatively, to the formation of three committees where one would serve, plus yet a fourth committee to 'co-ordinate' the other three.

For these reasons every effort is being made in East Africa to develop horizontal contacts (direct communication on scientific matters between opposite numbers) instead of the usual vertical system employed for administration purposes. The arrangements outlined below are tentative and will, no doubt, be improved with experience. The East Africa High Commission has created an Advisory Council for Agriculture, Animal Industry and Forestry, composed of government, technical and unofficial representatives from each Colony, with the directors of the Agriculture and Forestry and Veterinary Research Organizations, and the other non-government research centres already mentioned. This provides a forum for the general discussion of agricultural problems both scientific and practical. The Council is forming an increasing number of specialist committees on specific scientific problems, such as plant breeding, soil survey, insecticides. Their membership consists of a small number of the appropriate research and specialist officers from the research organizations and centres, and from the territories. They review the existing work in their subject and make suggestions for co-ordinating and extending it. They have scientific functions only, with no executive or administrative powers. These latter, and their financial implications, are exercised by the directors of the two Research Organizations and the directors of the territorial departments of agriculture, etc.; here, co-ordination is obviously necessary, and it is achieved by sub-committees consisting of the three directors of agriculture (or veterinary services, or forestry) with the director of the Agriculture and Forestry Research Organization or the Veterinary Research Organization as chairman. For matters such as animal husbandry, the agriculture and veterinary sub-committees meet together. Because these sub-committees have administrative and financial responsibilities they are not responsible to the Advisory Council but to another body, the Research Organization's Committee. This Committee can be regarded as an embryonic governing body for the Agriculture and Forestry Research Organization and the Veterinary Research Organization. It has a small membership: the Members for Agriculture of Kenya and Tanganyika, with a government official from Uganda, which does not have the Member system; one non-official from each territory who is a member of the Central Legislative Assembly of the East Africa High Commission; the directors of the two Research Organizations, and one High Commission officer, with the Administrator—the chief executive officer of the High Commission—as chairman.

It is hoped that, by these means, there will be quick and effective decisions on the scientific aspects of programmes of work, and on the executive and financial aspects as well.

There is one generalization that has guided the developments just described. This is the recognition of the fact that, in general, the sequence between discovery and introduction to practice falls into three phases: first, basic or fundamental research that discloses a new fact or a general principle; second, technological investigations, consisting of a series of systematic experiments to see how the new knowledge is affected by the range of variation within the regional environment; third, the introduction of the results of the second phase into practice. The regional research organizations are, normally, responsible for the first phase, and the territorial departments for the third phase. But both are equally concerned in the second phase, and it is here that effective and economical team-work is achieved between the Research Organizations and the territorial departments.

UNSTABLE PLANETARY CONFIGURATIONS

By Dr. W. H. RAMSEY

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THE present article describes a new type of planetary instability which arises in connexion with the theory of the internal structure of the earth which I have developed[1]. I attribute the sharp core discontinuity at about half-way to the centre of the earth, at which the density almost doubles[2], to a phase transition under pressure. This is in contrast to the older view that the core is iron which has separated under gravity from the less dense silicates of the surrounding mantle. In the new theory, the enormous pressure of 1·4 million atmospheres at the boundary of the core is presumed to have partially destroyed the molecular structure of olivine, the principal constituent of the mantle. The olivine in the mantle has the familiar ionic structure; in the core it is in a dense metallic state. In an ordinary polymorphic transition, in which the molecules are merely rearranged into a different crystal structure,

the density changes by only a few per cent. But in a transition to a metallic phase, in which the molecules themselves are partially destroyed, the increase in density will be of the order of 100 per cent.

The transition of a non-metal to a metallic phase is not a common occurrence in the laboratory. Usually a pressure of the order of a million atmospheres is necessary to make a non-metal metallic, and the highest pressure so far attained is only 100,000 atmospheres. But both metallic and non-metallic modifications of a few elements exist under laboratory conditions; examples are white and grey tin, metallic and yellow arsenic, black and yellow phosphorus. The metallic modification is always considerably denser; metallic arsenic is more than 2·5 times as dense as the yellow allotrope. The new interpretation of the core in terms of a phase transition is compatible with all seismic evidence of the earth's internal structure, and it accounts for some features not previously explained.

The new theory receives considerable support from the observed mean densities of the terrestrial planets. Jeffreys[3] has shown that, on the iron core hypothesis, the terrestrial planets have different chemical compositions; the smaller planets have relatively smaller cores, and so smaller proportions of iron. This is difficult, if not impossible, to reconcile with the planets having a common origin. The difficulty is removed by the new interpretation of the core. The new theory, together with the assumptions current in geophysics, implies that the variation in density within the earth is due mainly to the influence of pressure and not to changes in chemical composition. It is true that the crust contains a number of chemically distinct layers, but they account for only one per cent of the total mass. The pressure–density relationship for the material of the earth, which can be derived from seismic data[2], has been used to compute the mean densities of smaller planets of similar composition. It is found that all the terrestrial planets have the same chemical composition[1]. The smaller planets have smaller cores because of their smaller central pressures; and in the smallest planets, Mars and Mercury, the pressures are too low to support a core.

In the course of these calculations on the terrestrial planets, it was found that the smallest planetary cores are unstable and so would not occur in Nature. This feature is a direct consequence of the main assumption underlying the calculations, namely, that the jump in density at the boundary of the core is controlled by pressure. This phenomenon, which has recently been examined in some detail by Lighthill[4] and myself[5], may have played a significant part in the evolution of the solar system. To illustrate the effect, I have made calculations[5] on planets composed of a material which has a constant density ρ_0 at all pressures below a critical pressure p_c, and a constant density $\lambda\rho_0$, which is greater than ρ_0, at all higher pressures; in other words, both phases of the material are assumed to be incompressible. The central pressure always specifies the planetary configuration unambiguously; that is, the central pressure determines uniquely the mass and radius of the planet and the radius of its core. The radius of the core is necessarily an increasing function of the central pressure. But, for very small cores, the mass and radius of the planet are decreasing functions of the central pressure if the density jump at the boundary of the core exceeds 50 per cent (that is, if $\lambda > \frac{3}{2}$). The relationship between the mass M of the planet and the central pressure is illustrated in Fig. 1; the behaviour of the total radius is qualitatively similar. The mass M is a continually increasing function of the central pressure if the parameter λ does not exceed $\frac{3}{2}$; any planet of given mass has therefore only one possible equilibrium configuration. But if λ exceeds $\frac{3}{2}$, a mass M in a certain critical range

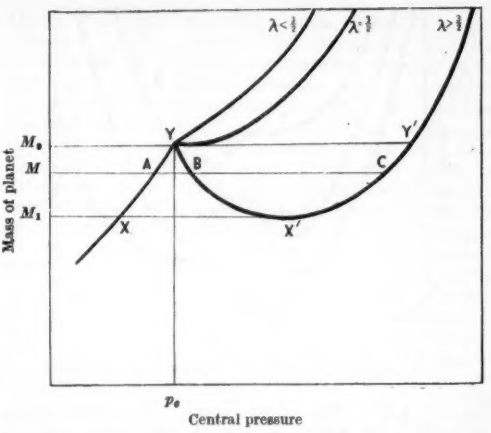

Fig. 1. Behaviour of the mass M of a planet as a function of the central pressure

$$M_1 < M < M_0 \qquad (1)$$

is compatible with three different planetary configurations, denoted by A, B and C in the diagram. Configuration A has no core, and B has a smaller core than C. In general, the three configurations have different total radii and different degrees of stability.

Lighthill[4] has extended these considerations to the general case of planets composed of a material the density of which is a continuous function of the pressure up to a critical pressure p_c, and at the critical pressure the density is assumed to jump discontinuously from ρ_0 to $\lambda\rho_0$. Lighthill has shown that the derivative (dM/dP) of the mass of the planet with respect to the central pressure P changes discontinuously by a factor

$$(3 - 2\lambda)/\lambda^2 \qquad (2)$$

when the central pressure is equal to the critical pressure p_c. The derivative with respect to P of any other bulk characteristic, such as the radius of the planet, changes by the same factor. This factor is positive if λ does not exceed $\frac{3}{2}$, and so the mass M is a continually increasing function of the central pressure as shown in Fig. 1. But the factor (2) is negative if λ exceeds $\frac{3}{2}$, so that (dM/dP) changes sign. As the mass M cannot decrease with P indefinitely, the behaviour must be qualitatively as shown in Fig. 1. The earlier considerations therefore apply also in the general case of a compressible material. Using Bullen's[2] estimate of the density distribution within the earth, it is found by numerical integration that the planet with its centre at the critical pressure has the following mass and radius:

$$M_0 = 0{\cdot}80\ M_E, \qquad R_0 = 6{,}300\ \text{km.}, \qquad (3)$$

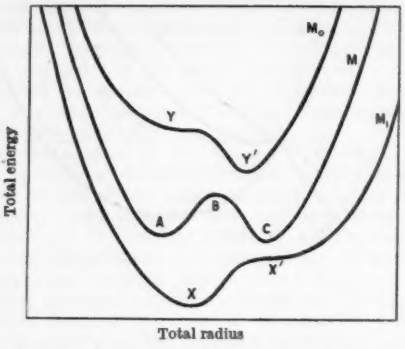

Fig. 2. Energy of a planet as a function of its total radius

M_E being the mass of the earth. The mass range $(M_0 - M_1)$, in which a planet has three possible equilibrium configurations, is only about 0·02 M_E. The total radii of different configurations of the same planet may differ by more than 100 km.

Fig. 2 shows schematically the energy of a planet as a function of its total radius; the letters A, B, etc., refer to the same equilibrium configurations as in Fig. 1. The middle curve refers to a general mass in the interval (1). Configurations A and C with minimum energies are stable; A has no core, and C has a large core. All configurations with small cores are of type B and are unstable; a small disturbance will cause a transition to either A or C. It is estimated that for stability the core of a terrestrial planet must be at least 1,000 km. in radius. For this reason the phenomenon is referred to as "the instability of small planetary cores". The top and bottom curves in Fig. 2 refer to the masses M_0 and M_1, which are special cases. For these masses a maximum and a minimum in the energy diagram coalesce to give a point of inflexion, and there is only one stable configuration for each mass. For mass M_0 the stable configuration is Y', which has a core; for mass M_1 the stable configuration is X, which has no core. The total energy of the stable configuration C with a core may be greater than or less than that of configuration A without a core, depending on the mass of the planet. The difference in energy between the two stable configurations is greatest near the ends of the critical mass range (1), that is, for masses near M_0 and M_1. The energy difference is estimated to be 10^{36}–10^{37} ergs—sufficient to remove from the surface of the planet a mass between 0·001 M_E and 0·01 M_E. Earthquakes release about 10^{26} ergs per year, and an atomic bomb about 10^{21} ergs. Thus if a planet were to undergo a transition from one configuration to another, the energy released would be enormous by ordinary standards. The transition would take minutes, or at most hours, and the energy released in this brief period would exceed that released by earthquakes during the whole of geological time. The energy liberated is always partly in the form of vibrations of the planet as a whole, but in some transitions a large fraction of the energy goes into blast waves. These blast waves, the pressure amplitude of which will be hundreds of thousands of atmospheres, will travel through the planet to the outer surface. The material on the surface will be shattered by the sudden impact of such large pressures, and fragments may fly off the planet into space. The mass of material removed may be of the order of 0·001 M_E. It is tentatively suggested that this mechanism may have been responsible for meteorites, and possibly also for the asteroids.

A planetary transition of the type envisaged will occur if the planet's mass M crosses the critical range (M_0, M_1) in either direction. The planet's mass could have changed gradually due to the aggregation of material or to the loss of light elements, depending on the mode of formation of the solar system. Alternatively, a planet could cross the critical range because of changes in the critical masses M_0 and M_1, which are functions of the internal temperature of the planet; a reasonable change in temperature could alter the critical masses by 10 per cent, and the mass of Venus is only 2 per cent greater than M_0. A planet must acquire a core if it crosses the critical mass range (1) in one direction, and it must lose its core if it crosses in the opposite direction. The core must be large at formation or disappearance since small cores are unstable; the planet must therefore undergo a transition of the type described. Venus and the earth may have undergone such transitions. The idea of an 'exploded planet' is an old one, but this mechanism makes an 'explosion' plausible for the first time. The irregular shapes and rough surfaces of the asteroids suggest that they have originated in this way. Meteorites also seem to be fragments of an 'exploded planet'. Local chemical separations, such as are apparent in stony meteorites and are necessary to account for iron meteorites, could only have occurred in a planet. In my opinion, the material of the earth below the crustal layers probably consists of ultrabasic rock with pockets of iron, such as would correspond to a representative mixture of all meteorites. Brown and Patterson[6] have recently advanced strong chemical evidence that meteorites were formed at high pressures, such as would occur in the central regions of a small planet or in the outer layers of Venus or the earth.

The present theory differs in one important respect from the old concept of an 'exploded planet'; the material removed is representative of the surface layers and not necessarily of the whole planet. Meteorites are not, of course, of the same chemical composition as surface rocks; but the transition envisaged would occur before the interior became quiescent, and so before the formation of a crust. As regards radioactivity, meteorites may be abnormal if they have originated from the surface layers of a planet; the earth's radioactivity is largely concentrated in the outer 50 km. There is circumstantial evidence that the radioactive content of meteorites is an order of magnitude greater than that of the earth as a whole.

Bullen[7] has suggested that the phenomenon under discussion may have a bearing on the origin of the moon. He reconsiders the old theory in which the moon is supposed to have been torn from the earth by a resonance tidal action of the sun. This theory has been in disrepute since Jeffreys[8] pointed out that internal damping would prevent the necessary build-up of amplitude. Bullen proposes that the function of the tidal resonance is primarily to induce a planetary transition of the type C to A in Figs. 1 and 2. He assumes that the primitive earth-moon body, due to its higher central pressure, contained within the central core another and denser core. This additional core disappeared when the moon was formed, and its disappearance released

the energy necessary to separate the moon from the earth. It is highly desirable that this idea be examined quantitatively.

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OBITUARIES

Academician S. I. Vavilov

THE death of S. I. Vavilov at the age of sixty, which occurred on January 25 of this year, was a heavy loss to science in the Soviet Union, for he was not only a great man of science but, even more, one of the founders of science in his country.

Vavilov entered the University of Moscow in 1909 and worked under F. N. Lebedev, whose researches on the physics of light absorption were to furnish the theme of Vavilov's scientific career. His first paper, on "The Effect of Heat on the Fading of Dyestuffs", was written before he left the University in 1914 with other members of the staff and students as a protest against police persecution in the University. After a period of war service, in which he worked on radio physics, Vavilov found himself one of the small band of trained physicists, not more than forty in number, with the immense task of building up physical teaching, research and application in the new Soviet Republic. He managed to combine this with the furtherance of his own research in the field of physical optics. The chief contribution was embodied in some hundred papers on fluorescence and phosphorescence of dyestuff molecules. He elucidated, by a combination of experimental and theoretical study, the laws governing the quantum yield of fluorescence, the maintenance of excited states, particularly at low temperatures, and the explanation of impurity quenching, and self-quenching of fluorescence. This work, which linked with that of Frank and Pringsheim, he summed up in a paper in 1945[1] and in a semi-popular book, "The Microstructure of Light"[2]. His study of fluorescence led him into the field of the physiology of vision, especially in the quantum effects that can actually be observed at very low light intensities. He was also, in his latter years, largely responsible for the study of the 'shock wave' radiation from electrons moving faster than the speed of light in the medium through which they pass.

Vavilov's scientific work was always closely linked with that of the organization of research. Before 1917, Russia had imported practically all optical apparatus from abroad, largely from Germany. It was then decided to build up a State Optical Institute in Leningrad, where research and development were to lead into full-scale production. Vavilov played a major part in the building up of the Institute and, in particular, in establishing the production of fluorescent lighting.

These activities by no means used up all his intellectual capacity. Indeed, it was from them that he acquired an intimate knowledge and practical experience of the relation of science to social needs. He showed this first in his studies on the history of science; British readers will remember his contribution to the Newton tercentenary, where he threw new light on Newton's atomism and its intimate connexion with optics and chemistry[3]. He had also thought profoundly on the philosophy of physical science[4], particularly of the factors that led to the twentieth-century revolution in physics, which he attributed in the first place to Maxwell's use of mathematical hypotheses. On the practical side, his wide understanding qualified him first to contribute to and ultimately, as president of the Academy, in 1945 to co-ordinate and direct the work of Soviet scientists in the solution of the great practical problems involved in transforming the economy of the country. He was a deputy both to the Russian and Union Supreme Soviets, and his advice was taken in all problems involving science[5,6]. In the international field, despite all difficulties, he was always a firm supporter of the need for the co-operation of scientific workers of all countries in building a peaceful world.

Vavilov as a man had a quiet dignity. He did not impose himself on others but commanded respect by the rationality of his judgments and the integrity of his character. His death in harness was probably due to overwork; but he had already contributed more than his share to his country. He will be counted with Lomonosov as one of the great builders of science in the U.S.S.R. J. D. BERNAL

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Dr. K. C. Bailey

DR. KENNETH CLAUDE BAILEY was born in 1896 and educated at St. Andrew's College, Dublin. He entered the University of Dublin in 1913, where he immediately earned fame by taking, when still only a junior freshman, first place in the examination for classical scholarships, an honour which is usually obtained only by men of senior freshman or junior sophister standing. The First World War, in which he served from 1915 until 1919, interrupted his academic career, and when he returned to Trinity College after demobilization he continued his classical course and also commenced to study experimental science. In 1921 he obtained brilliant degrees in both these subjects, and afterwards worked for about a year in the University of Toulouse under Prof. Sabatier, where he obtained a doctorate in science. A few years after his return to Trinity College as lecturer in chemistry he was elected in 1926 to a fellowship, which he continued to hold until his death.

He married in 1923 Miss Dorothy Lavelle, who is also a science graduate of the University of Dublin, where their only child, Miss Pauline Bailey, is now studying medicine.

In the space available it is quite impossible to give any adequate picture of Dr. Bailey's multitudinous activities since 1926. It may be said that his principal public interests were mainly threefold, embracing chemistry, classics, and the administration of the

affairs of Trinity College, Dublin. In all three he did notable and memorable work.

His reputation as a chemist will probably rest on his work on the inhibition of chemical reactions, on which he contributed a long series of papers to the scientific publications of the Chemical Society, the Royal Irish Academy, the Royal Dublin Society, and others. In 1937 he published his book, "The Retardation of Chemical Reactions", which appears to be the first general treatment of this subject that had appeared in any language. It represents the experimental and literary research of more than a decade. Its thoroughness can be judged from the fact that the bibliography alone contains some 1,600 references to original papers. He intended to publish a second edition, and had done most of the preliminary spade-work, but unfortunately his other occupations postponed the fulfilment of this intention, and owing to this occurrence chemical science is undoubtedly the poorer. During the Second World War he assisted the Irish Emergency Research Bureau in its attempt to alleviate the local shortage of certain essential materials. Among other problems, he worked out the details of the production of potassium chlorate, needed for the match industry, from sodium chloride and kelp. This process was eventually developed on a fairly large scale towards the end of the War.

On the classical side, Bailey published two books, the titles being "The Elder Pliny's Chapters on Chemical Subjects", and "Etymological Dictionary of Chemistry and Mineralogy", in the latter of which his wife, Dr. Dorothy Bailey, collaborated. He was also greatly interested in the development and history of chemistry, and wrote several articles on these subjects for various journals.

It might be thought that with his teaching duties as lecturer, and later as professor of physical chemistry, and the quantity of original work he produced, Bailey would have found little time for administrative duties. This, however, is far from true. He held the onerous and rather thankless post of Junior Dean of Trinity College for a period of eleven years, a term of office which has only once been exceeded in length during the history of the College. He was a member of the Board of the College for twenty years, first as a representative of the Junior Fellows, and since 1942 as registrar. During this period he was instrumental in introducing several excellent reforms. It is perhaps a pity, from the scientific point of view, that his duties as registrar very largely curtailed his original chemical research work after 1942, although he continued to lecture in the Chemical School until his retirement, due to ill-health, in October 1950. He did, however, find time to write an interesting and very readable volume entitled "The History of Trinity College Dublin from 1892 to 1945" during his later years.

Of Bailey's personal characteristics one finds it hard to write. He was always the most pleasant and courteous of colleagues, always ready to help in any problem proposed to him. As might be expected from a man of his calibre, he held very definite views on many subjects; but he was never dictatorial in expressing them, and always willing to listen to contrary opinions.

Trinity College, Dublin, may long and truly mourn

"A man so various, that he seem'd to be
Not one but all mankind's epitome".

J. H. J. Poole

NEWS and VIEWS

Zoology at University College, London : Prof. D. M. S. Watson, F.R.S.

The new term has begun at University College, London, without the official attendance of this distinguished zoologist. It was in 1912 that Mr. David Watson joined the College staff after a brilliant student career at the University of Manchester. Already he was the author of papers to which reference is still made. From that date until 1921 he was lecturer in vertebrate palæontology. He was absent, it is true, during part of the First World War as a lieutenant in the R.N.V.R.; but even there his palæontology was not forgotten, and he was largely responsible for the design of a pterodactyl type of aircraft that later was to take the air. In 1921 he succeeded Prof. J. P. Hill in the Jodrell chair of zoology and comparative anatomy at University College. There he has created not only a school of zoology, but also has attracted numbers of graduate students in zoology and palæontology who have themselves gone to chairs of zoology or geology. Some years before the Second World War he had the task of remodelling commercial premises to his departmental purposes in the Malet Place buildings of the College.

During these arduous and fruitful years Prof. Watson has also made opportunities for world-wide travel and for collecting expeditions in which he has visited Canada, the United States, South Africa, the Soviet Union, Scandinavia and Ceylon, and he has visited every site of importance to vertebrate palæontology in Great Britain. His many contributions to the study of fossil fishes, on the origin and development of the amphibians, and on many groups of fossil reptiles are too well known to need comment here. These, with his ease and clarity as a lecturer, have made him welcome in many assemblies and conferences. Among his many honours is the Darwin Medal of the Royal Society. Since the War he has been a trustee of the British Museum. Prof. Watson was sixty-five on June 18 and the event was celebrated in his department with a tea-party, when he was presented with an album of photographs and signatures of many of his friends, pupils and admirers from all over the world. His last term of office was clouded by an illness. Happily he has recovered his full vigour and will continue his researches in the familiar surroundings of University College. His friends and colleagues will wish him many happy years of work, and pleasure in his library and his collection of Oriental art. Prof. Watson has been succeeded by Prof. P. B. S. Medawar, Mason professor of zoology in the University of Birmingham (see *Nature*, **160**, 14; 1947).

Television in the North of England

The scheme of the British Broadcasting Corporation for establishing television on a nation-wide basis moved another step forward on October 12, when the North of England station at Holme Moss was opened for public service by Lord Simon of Wythenshawe, chairman of the governors of the

Corporation. In order to cover the greatest possible area in the central and southern portions of the North of England, the site of the Holme Moss station was chosen in a very high and isolated region some sixteen miles east-north-east of Manchester. The altitude of the site is 1,700 ft.; and this, with the mast, which is similar to that of the station at Sutton Coldfield, Birmingham, results in the height of the aerial being some 2,450 ft. above sea-level. The carrier frequencies of the vision and sound transmitters are 51·75 and 48·25 Mc./s., and the corresponding powers are 45 and 12 kW., respectively. The resulting range for good and reliable reception is expected to be between fifty and seventy miles, depending upon local conditions and the nature of the intervening terrain. It has already been reported that the opening programme was received clearly in North Wales at a distance of about eighty miles.

Due to the exposed position, special precautions have been taken in the design of the buildings and the mast to ensure that they will stand up to the severe blizzards and gales which will almost certainly be experienced during most winters. The task of maintaining and operating the station will not be easy or pleasant; and arrangements have been made for the staff to live on the station when access becomes difficult or impossible owing to snow and ice. The Holme Moss transmitter is connected to the Birmingham and London television stations by a special coaxial cable installed by the General Post Office. This cable transmits programmes in either direction as required; and it provided a very satisfactory means of viewing, in the London area, the inaugural ceremony of the new station in the Manchester Town Hall, and a programme from the Theatre Royal, Leeds, on the following evening.

Thousandth Issue of *The Practitioner*

First published in 1868, *The Practitioner* has celebrated its thousandth issue (vol. 167, October 1951), providing, in addition to its usual features, thirteen valuable articles on advances in various aspects of medicine and surgery. All these articles are written by distinguished specialists in the fields they cover. There is also an article by Sir Henry Dale entitled "The Changing Face of Medicine, 1868–1951", another by Sir Henry Bashford on "The Social Background of Medicine" and a third by Dr. W. N. Pickles entitled "Trends of General Practice: a Hundred Years in a Yorkshire Dale". The whole issue thus constitutes an epitome of the immense advances that have been made in the past hundred years or so, and it worthily enshrines the very great benefits that medicine has conferred upon us during this period. In these benefits the animals, especially the domesticated animals, have shared, and one of the inspiring trends, not specifically noticed in these pages, is the increasing co-operation between the medical and veterinary professions. It is impossible to select from so many excellent articles any that are more valuable than the others. The layman will find a great deal that will interest and encourage him in the three papers already mentioned; Dr. Pickles, in his sketch of three generations of practitioners, re-creates for us that great and tireless 'guide, philosopher and friend', the general practitioner of an age that many readers will know only in literature. *The Practitioner* has proved, with this issue, that it is as vigorous and progressive as it has ever been, and it would not be easy to find, for any scientific journal, contributors more skilled in the art of explaining, pleasantly and effectively, the intricate matters that are the busy medical practitioner's everyday concern.

Institute of Metal Finishing

The Council of the Electrodepositors' Technical Society announces that application for official incorporation has now been granted; also permission has been given for the adoption of a new title embracing metal finishing generally (excluding only vitreous enamelling). This is in accordance with the general policy of the Society to extend its field beyond electrodeposition processes to include metal finishing generally, with which the bulk of its members are vitally concerned. The new title by which the Society will henceforth be known is 'The Institute of Metal Finishing incorporating Electrodepositors' Technical Society Limited'. The original aims and objects of the Society, namely, to promote the study of, and disseminate information on, electrodeposition and cognate processes as widely as possible, are in no way affected by these changes. The sphere of interest has now been significantly widened and the Council is of the opinion that this will bring with it corresponding benefit to the membership. The executive officers and Council of the Electrodepositors' Technical Society have become the officers of the new Institute. The present executive officers are: *President*, Mr. H. Silman; *Honorary Secretary*, Dr. S. Wernick; and *Honorary Treasurer*, Mr. F. L. James. The headquarters of the Institute are at the Northampton Polytechnic, St. John Street, London, E.C.1; all communications should be addressed to the Honorary Secretary at 27 Islington High Street, London, N.1.

Agricultural Research Council: Potato Genetics Station

The Commonwealth Potato Collection, Huntingdon Road, Cambridge, which was formerly a responsibility of the Commonwealth Agricultural Bureaux, has recently been transferred by agreement to the control of the Agricultural Research Council and will in future be known as the Potato Genetics Station. In 1939 the Commonwealth Agricultural Bureaux organized an expedition to Mexico and South America to collect varieties of wild and cultivated potatoes in their native home; and the collection based on the samples brought back has been housed since 1945 in a building erected, through the generous financial assistance of the Nuffield Foundation, on a site provided free of cost by the University of Cambridge. In the past ten years, description and classification of the collection have been completed, and the reactions of the material to certain virus diseases, eelworm, late blight, wart, frost and other factors have been studied. Some work on the chemical content of tubers has been carried out, but much remains to be done. This comprehensive collection would seem to offer valuable material for comparative biochemical studies in a vegetatively propagated crop plant. Students in several Commonwealth countries co-operated in this first phase of the work, and material has been widely distributed for the use of potato breeders at home and overseas.

The change in administrative responsibility marks the beginning of a second phase of development, in which the collection will be used mainly for genetic research. The programme includes studies of resistance to various diseases, with a view to the synthesis of lines for the potato breeder, and investigation of

the general problems of genetical history and differentiation in the tuberous species of *Solanum*. The valuable research material that has been assembled will thus continue to be used to the ultimate advantage of the potato industry. The Potato Genetics Station is under the direction of Dr. K. S. Dodds.

Acustica : A New International Journal

The first two numbers have recently appeared of *Acustica* (Zurich: Hirzel-Verlag, 1951; 36 Swiss francs a year), a new international journal sponsored by the Acoustics Group of the Physical Society of London. There have been previous attempts to start national acoustical journals in both France and Germany, but neither of these survived the Second World War. In recent years hopes have been expressed for a revival of these and for the setting-up of a journal in English on the eastern side of the Atlantic, sponsored by the respective groups of scientific workers and technicians interested in acoustics. Eventually it was decided to combine these efforts and to found a journal which should publish articles received in English, French or German of any origin but particularly those coming from European countries and from countries associated therewith, such as the British Commonwealth. Dr. C. W. Kosten, of Delft, was appointed editor-in-chief, and Dr. E. G. Richardson, of King's College, Newcastle upon Tyne, is the editor for papers submitted in the English language. *Acustica* will appear six times a year and will publish from time to time additional one-language supplements under subvention by one or other of the national groups. (One such supplement, in German, has already appeared.) For the main journal, up to the present more papers have been received in English than in any other language, but those printed in the first two issues include some in all three languages. Between them they cover the subjects of building acoustics, subjective sound, musical acoustics, ultrasonics, loud-speakers and the history of sound. It is indeed the aim of the editors that fundamental, and not only technological, aspects of sound shall be well represented in the journal.

Study of the Arthropod Mandible

It is generally accepted that the mandibles of an arthropod have evolved from a pair of limbs in a primitive ancestral form, though precisely which part or parts of the limb is involved is still a subject of discussion. The typical, primitive arthropod limb consisted of a basal coxopodite or coxa and a distal segmented telopodite. The coxa was articulated dorsally on the tergum and ventrally on the sternum, and the limb was moved antero-posteriorly probably by a pair of dorsal muscles originating from the tergum and a pair of ventral muscles originating from the sternum or an endophragmal projection therefrom. These muscles may be termed the dorsal promotor and remotor and the ventral promotor and remotor, respectively. A change in the position of the points of articulation or in the places of origin of the muscles or both would, of course, bring about a change in the direction of movement of the limb. Starting with these quite reasonable assumptions, R. E. Snodgrass has carried out a most interesting series of "Comparative Studies on the Jaws of Mandibulate Arthropods" (Smithsonian Misc. Coll., 116, No. 1; pp. 85. Washington, D.C.: Smithsonian Institution, 1950). He points out that in many Entomostraca, some Malacostraca and the Machilidæ, the mandible most clearly resembles this idealized coxa in structure and musculature, bearing in mind that there is no sternum as its place is occupied by the mouth. The work traces the various modifications and specializations that are to be found in all groups of mandibulate arthropods. The text is illustrated with twenty-five text-figures and the majority of these have seven or eight individual diagrams.

Annual Conference of Aslib

In what circumstances are mechanized aids quicker or slower than human beings in selecting information from a wealth of coded material? Can the flow of work in a library be usefully compared with that in a process plant when planning layout? Would the use of intelligence and aptitude tests help in choosing a better information officer? These are typical of the questions raised at the twenty-sixth annual conference of Aslib held during October 5–8 at Ashorne Hill, the conference centre of the Iron and Steel Corporation near Leamington Spa, and attended by nearly two hundred and fifty delegates. The theme of the conference was 'design for efficiency'. The particular fields in which problems of increasing efficiency were studied were: international bibliography; optimum use of staff and training the user; and the future development of Aslib. The formation of subject groups within the framework of Aslib in the fields of aeronautics, food and agriculture, textiles and economics stimulated lively discussion. Some constructive co-operative plans for rationalization in the purchase, listing and loan of periodicals, for exchange of staff, and for translation have already been initiated. In the sessions on choosing, training and directing staff, and on training and directing the (unchosen) user, scientific and statistical methods of assessing the problems attracted the interest of delegates. It was noticeable that attempts to measure the capabilities of persons and the efficiency of processes are increasing. Unesco's efforts to stimulate the development of bibliographical services in underdeveloped areas and to tidy up the existing services elsewhere were described in a paper submitted by the head of the Libraries Division of Unesco. Added interest was provided in this session by contributions both from members of the Organization for European Economic Co-operation (O.E.E.C.) mission at present touring Europe to study technical information services, and also from delegates recently returned from the Conference of the Fédération Internationale de Documentation in Rome. The Conference not only provided the usual stimulus of contacts between specialists, but also raised problems that may be profitably pursued by smaller groups in the future.

University of Birmingham

The following appointments have recently been made in the University of Birmingham: P. J. Palmer, formerly of the Boulton Paul Aircraft Co., to be lecturer in civil engineering; J. H. O. Varley, to be lecturer in metallurgy. The following resignations from the University have been announced: Dr. E. S. Twyman, lecturer in botany, on appointment as professor of botany in Rhodes University, Grahamstown; W. S. Norman, lecturer in chemical engineering, on appointment as lecturer in chemical engineering in University College, London; Dr. A. J. Wilson, lecturer in mechanical engineering, on appointment to the Metals Division of Imperial Chemical Industries, Ltd.; Dr. Mary Gregg, lecturer in botany, on appointment as lecturer in botany in University

College, Dublin; Dr. Vera Norris, senior statistical officer in the Department of Medical Statistics, on appointment as medical statistician at the Maudsley Hospital, University of London.

Postgraduate Agricultural Scholarship Awards

THE Ministry of Agriculture and Fisheries has awarded postgraduate research and training scholarships in the following subjects, tenable in the first instance at the university or institute shown for periods up to three years from September 1, or later. *Agricultural Economics:* E. A. Attwood, School of Agriculture, Cambridge; and K. C. Abercrombie, P. N. Barker, S. A. Bradburn, A. A. Marsh, J. D. Sykes and Miss F. R. Walker, Agricultural Economics Research Institute, Oxford. *Agricultural Engineering:* P. R. Attwood, D. P. Blight, D. J. B. Calverley, A. J. Crowther, J. L. Manson, W. T. B. Marchant, J. J. Thomas and M. A. Keech, King's College, Newcastle upon Tyne. *Husbandry:* A. J. Abbott, W. H. Broster, S. C. Meadowcroft, P. Radford, K. W. G. Shillam and Miss J. P. Tibbitts, University of Reading; D. Archer and R. J. Colley, University of Leeds; B. F. Bland, A. W. Court, F. K. Deeble, B. C. Knight and R. P. Voelcker, School of Agriculture, Cambridge; Miss D. E. Fisher, University of Nottingham; J. Sherwell and B. R. Watkin, Wye College, University of London; and J. G. Watkin Jones, Rowett Research Institute, Aberdeen. *Agricultural Statistics:* Miss A. W. Boyes, University of Oxford; and F. R. Latham, University of Manchester.

Commonwealth Fund Fellowships for Study in the United States

THE Commonwealth Fund of New York (41 East 57th Street, New York 22) is again offering a number of Commonwealth Fund fellowships to British subjects for study and travel in the United States. The fellowships provide for all expenses of travel, study and living, with some adjustment for married men with families. The fellowships, which are open to British men or women who are not normally resident in or near the Americas and who have not previously worked or studied for more than a few months in the United States, are offered annually in six categories as follows. *Ordinary:* twenty fellowships to graduates of a university in the United Kingdom of Great Britain and Northern Ireland. Candidates must be available in London for interview in March 1952; age, 23–35; tenure, 12–21 months; applications by December 15. *Home Civil Service:* five fellowships to permanent members in the higher ranks of the Civil Service in Great Britain, three for the administrative grades and two for the scientific and professional grades. Age, less than 40; tenure, 6–12 months; applications by December 31 to the Treasury. *Dominion Civil Service:* five fellowships to Civil servants in the Governments of Australia, New Zealand and South Africa. Age, less than 40; tenure, 12–21 months; applications by February 1. *Colonial Civil Service:* two fellowships to Civil servants in the Governments of the British Colonies, Protectorates, and Trust Territories. Age, less than 40; tenure, 12–21 months; applications by December 31 to the Colonial Office, London. *Journalism:* three fellowships to journalists practising in the United Kingdom and engaged on the opinion-making or broadly editorial side of their profession. Age, 23–35; tenure, 9–15 months; applications by January 1, 1952. *American Studies:* four fellowships will be available to faculty members appointed to or holding posts in American studies in universities in the United Kingdom, candidates to be nominated by their universities; tenure, 4–12 months; these fellowships are not limited by previous study in the United States. Application forms and further details of these fellowships can be obtained through British universities or through government departments, or from the Warden, Harkness House, 35 Portman Square, London, W.1.

Announcements

H.R.H. the Duke of Edinburgh has been elected an honorary member of the British Institution of Radio Engineers.

THE Franklin Medal, the highest honour given by the Franklin Institute, Philadelphia, has been awarded to Sir James Chadwick, master of Gonville and Caius College, Cambridge, for his work in nuclear physics.

PROF. P. TH. OOSTERHOFF, Sterrewacht, Leyden, has been appointed assistant general secretary of the International Astronomical Union. Prof. Bengt Strömgren remains general secretary of the Union.

THE Committee of the Privy Council for Agricultural Research and Nature Conservation has reappointed Sir Alan Drury, Director of the Lister Institute, to the Agricultural Research Council for a further term, and has also appointed Prof. S. J. Watson, professor of agriculture and rural economy in the University of Edinburgh, to fill the vacancy caused by the retirement from the Council, on completion of his term of office, of Prof. T. J. Mackie.

THE following appointments have been announced from the University of London: Dr. Ruth Bowden, to the University chair of anatomy tenable at the Royal Free Hospital School of Medicine; Dr. R. J. Harrison, to be head of the Department of Anatomy at the London Hospital Medical College, with the title of reader in anatomy in the University in respect of this post.

THE Société Française de Métallurgie will be holding a series of autumn sessions during October 22–27 at the Centre Marcelin Berthelot, Maison de la Chimie, 28bis rue St. Dominique, Paris 7^{e}. On each day papers will be read on a number of metallurgical topics. Further details can be obtained from the Society at 5 Cité Pigalle, Paris 9^{e}.

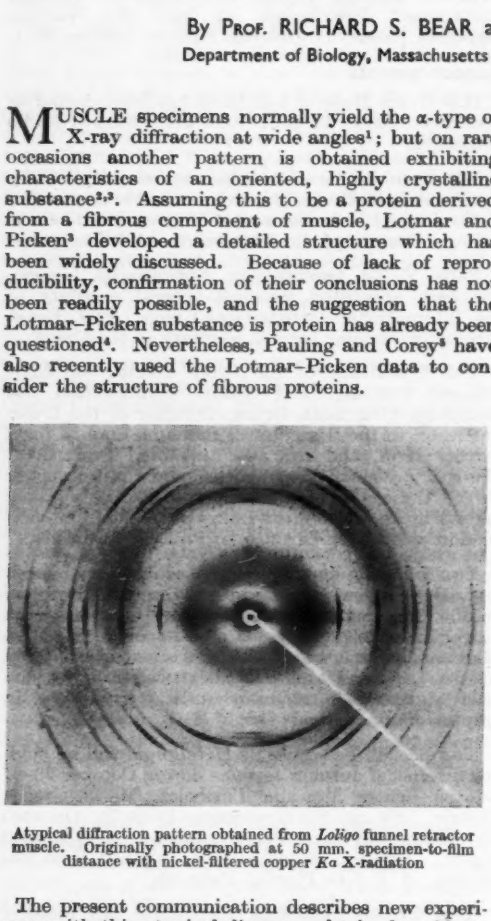
THE British Standards Institution has recently published "Methods for the Analysis of Soaps" (B.S. 1715 : 1951. Pp. 42; London: British Standards Institution, 1951; 5*s*. net). This document gives both the British Standard methods and also the methods of the International Commission for the study of fats. Full details of the analytical methods and of any special apparatus required are outlined.

THREE textile research fellowships have been created by the Commonwealth Scientific and Industrial Research Organization to enable research men trained in physics, chemistry or engineering to obtain special experience in textile science in the United Kingdom. The fellowships are being financed from money made available by the Associated Woollen and Worsted Textile Manufacturers of Australia. Fellows will be appointed for twelve months. They will receive a salary of £A1,000 per annum, plus travelling expenses. Further details can be obtained from the Secretary, C.S.I.R.O., 314 Albert Street, East Melbourne.

THE 'LOTMAR–PICKEN' X-RAY DIFFRACTION DIAGRAM OF MUSCLE

By Prof. RICHARD S. BEAR and Dr. CECILY M. M. CANNAN
Department of Biology, Massachusetts Institute of Technology, Cambridge, Mass.

MUSCLE specimens normally yield the α-type of X-ray diffraction at wide angles[1]; but on rare occasions another pattern is obtained exhibiting characteristics of an oriented, highly crystalline substance[2,3]. Assuming this to be a protein derived from a fibrous component of muscle, Lotmar and Picken[3] developed a detailed structure which has been widely discussed. Because of lack of reproducibility, confirmation of their conclusions has not been readily possible, and the suggestion that the Lotmar–Picken substance is protein has already been questioned[4]. Nevertheless, Pauling and Corey[5] have also recently used the Lotmar–Picken data to consider the structure of fibrous proteins.



Atypical diffraction pattern obtained from *Loligo* funnel retractor muscle. Originally photographed at 50 mm. specimen-to-film distance with nickel-filtered copper $K\alpha$ X-radiation

The present communication describes new experiences with this atypical diagram, obtained accidentally from *Pecten* adductor and *Loligo* funnel retractor muscles. The stronger features of the best diagram are seen in the accompanying reproduction. As shown in the table of observations, the new patterns contain many more individual arcs than have been observed before, including several on the second layer line.

The Lotmar–Picken diagram has now been observed in examples of the major types of muscle: smooth and striated, vertebrate and invertebrate. So far as we are aware, the pattern has never been derived from tissues other than muscle. In every case the orientation effects are closely related to those of the fibrous elements of the muscle.

The conditions required for development of the Lotmar–Picken crystals are still not evident. The present examples were air-dried under tension sufficient to maintain approximately resting length and had been stored for a few days (*Pecten*) to two months (*Loligo*, at 4° C.) before X-ray examination. A companion *Loligo* specimen, taken from the other side of the same squid funnel and treated similarly, except for stretching 30 per cent, exhibited the usual α-diagram. Attempts to test the function of tissue autolysis in the Lotmar–Picken effect, suspected in the *Pecten* case, failed to show any connexion.

Possibly the Lotmar–Picken crystals are developed at the expense of the fibrous structures of the muscles. Under comparable conditions of examination, samples yielding the Lotmar–Picken pattern show the α-diagram and associated small-angle diffractions (type II of Bear[6], similar to those of actin films[1]) somewhat less intensely than is normal.

There is little doubt that the present patterns have the same origin as those of previous investigators. Although several minor differences in the line positions and intensities may be noted in the table of observations, serious difficulties arise only with respect to the following positions: (*a*) on the equator near $\frac{\sin\theta}{\lambda} = 0.052$, and (*b*) near the meridian at the first layer line. Both these areas are ones to which the normal α-type diffraction, plus a certain amount of diffuse scatter, contribute a confusing background. As the reproduction shows, however, the present pattern offers particularly good opportunity for distinguishing the Lotmar–Picken reflexions from others.

Diffraction Positions on Atypical Muscle Diagrams

Figures are $\frac{\sin\theta}{\lambda}$ values. Letters indicate intensities as follows: S = strong, M = moderate, W = weak, VW = very weak.

Herzog and Jancke (ref. 2)		Lotmar and Picken (ref. 3)		Bear and Cannan	
Equatorial:					
0·050	S	0·054	S	(0·052)	W
0·077	M	0·076	S	0·076	S
0·086	M	0·084	VW	0·085	W
		0·106	S	0·106	S
0·127	W	0·126	W	0·125	W
		0·134	M	0·133	M
		0·143	M	0·143	S
		0·170	W	0·172	M
				0·180	VW
		0·182	W	0·183	W
		0·202	W		
		0·230	M		
First layer line:					
0·094	M			0·094	M†
				(0·099)	W
0·103	M	0·104	S	0·103	W
0·107	M				
		0·117	M	0·117	M
		0·126	M	0·124	S
0·144	W	0·138	M	0·139	M
0·161	W			0·174	M
		0·184	W	0·185	W
				0·196	VW
		0·199	W	0·200	W
		0·204	W	0·204	VW
				0·208	W
Second layer line:					
Bear and Cannan		Bear and Cannan		Bear and Cannan	
0·189	M†	0·209	W	0·239	VW
0·194	VW	0·213	VW	0·254	VW
0·200	VW	0·233	W		

Figures enclosed in parentheses are for background reflexions of the normal muscle *a*-diagram. True diatropic reflexions, corresponding to $b_0 = 5{\cdot}29$ A., are indicated by †. The equatorial region at 0·200 and beyond was not covered by present films.

While showing good radial sharpness, all spots are arced sufficiently to make decision as to certain indices and unit-cell dimensions difficult. The fibre-axis translation (b_0) is the only cell element clearly distinguishable. All non-meridional arcs of the first layer line, as well as diatropic reflexions on the first and second layer lines, indicate a value for b_0 of 5·3 A., as compared with the 5·65 A. suggested by Lotmar and Picken.

One may also ascertain that interferences comparable in sharpness and intensity with the others are not present at the position of the diffuse equatorial spot corresponding to the 'side-chain' spacing of the α-diagram. Diffraction in this region played a prominent part in the considerations of Lotmar and Picken and of Pauling and Corey. Our results throw considerable doubt on the correctness of the previously suggested unit cell, and also deny the validity of any structural conclusions which require, on the atypical muscle diagram, strong equatorial diffraction corresponding to spacings of about 10 A.

Crystalline proteins should show large cells the dimensions of which are functions of the large lengths and/or breadths of the molecules. Although the abnormal *Loligo* specimen yielded a single, partially oriented (equatorial) diffraction, corresponding to a spacing of about 50 A., this is independent of the Lotmar–Picken diagram, since on occasion similar diffraction has been observed in muscles failing to show the distinctive Lotmar–Picken phenomenon. The oriented rings observed in such cases are like those yielded by phospholipids[7], which are common tissue contaminants.

There remains the possibility, if protein is involved, that the wide-angle diffractions represent intramolecular diffraction from individual protein particles. This is excluded by the radial sharpness and the spotted character of the observed diffractions, which could not be produced by particles of size less than that reported for intra-myofibrillar filaments (breadths c. 100 A.)[8]. Several of the interplanar spacings observed for the Lotmar–Picken substance are as small as 2 A. or less, a magnitude which, though not impossible for a protein, is smaller than is usually encountered.

Additional indication as to the nature of the Lotmar–Picken substance was found in experiments employing solvents to disperse this material. The abnormal *Loligo* specimen was divided and one portion subjected to distilled water, another to benzene, for two days. After drying, neither specimen yielded the Lotmar–Picken diffractions, exhibiting only the normal α-diagram. Dispersion by water is rather inconclusive; but the solubility in benzene may narrow the possibilities. The water had weakened the intensity of the 50-A. ring mentioned above; but benzene removed it entirely. The more bulky sample of *Pecten* muscle was extracted with benzene, and upon concentration of the extract by evaporation of solvent the residue yielded a small-angle ring (43 A.) but no evidence of Lotmar–Picken diffraction.

Probably the Lotmar–Picken substance, while related in origin to the fibrous elements of muscle, is not a protein. It is more likely to be a small organic molecular species which usually remains hidden by complex formation or solid solution within or near the fibrous components. On occasions, the circumstances of which are unknown, this material may be released to form separate crystalline phases, much as the lipid components of the nerve myelin sheath separate from the protein upon drying[9]. While this view denies that the Lotmar–Picken diagram is of any direct significance for the problem of protein structure, the diagram may still retain considerable interest for conceptions of muscle structure.

[July 25.

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MOVEMENT OF PROTEINS ON FILTER PAPER

THE separation of proteins by chromatography has been described by several workers[1,2]. Recently, Franklin and Quastel[3,4] reported the separation of proteins on filter paper. They developed two-way chromatograms with a variety of solvents (sugars, amino-acids and sodium salts of weak dibasic or hydroxy acids). The importance of their work, and its possible value in clinical research, rendered it desirable to examine the movement of proteins on filter paper under the influence of different eluting solutions, and to follow the effect of the conditions employed on the appearance of the resulting chromatograms.

The factors concerned in the ultimate separation of a two-dimensional chromatogram are: (1) extension of the mixture from a single spot to form either an elongated band or a series of discrete spots along the origin of flow of the second dimension; and (2) separation of the components of this band to give the final pattern.

After certain preliminary experiments, it appeared doubtful whether either of these two conditions was fully met in the system under consideration, and further experiments were designed to study the

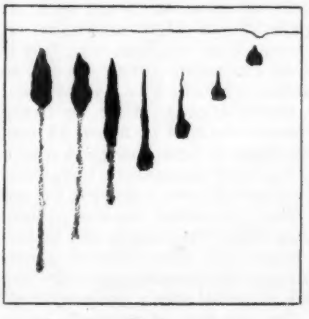

Fig. 1

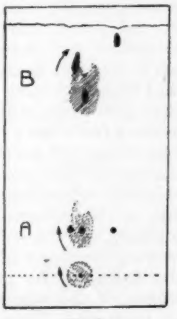

Fig. 2

Fig. 1. Diagram demonstrating the changing shape of protein spots at various intervals after the commencement of a chromatogram. The black area indicates the protein mass as demonstrated by ultra-violet fluorescence or iodine, the shaded area that which also stains blue with benzidine, showing that this indicator in part dissociates from the protein during the run

Fig. 2. Diagram demonstrating non-linear flow of solvent in neighbourhood of protein mass. When protein had reached *A*, spots of bromphenol blue were added at positions indicated. The relative movement of the component parts of the spot is shown by the positions of the bromphenol blue spots at *B*

mode of transport of mixtures of proteins such as occur in serum.

Following the conditions of Franklin and Quastel's experiment[4], serum and hæmin were mixed and 0·02 ml. dried on paper in a current of cold air. The chromatogram was developed by upward irrigation with 0·1 *M* glucose, lævulose, sodium glutamate, adipate malate or maleate solutions. To determine the shape of the protein mass after varying periods of time, spots were applied at increasing distances from the lower edge of the paper. When the solvent front had reached the uppermost spot and had flowed a distance of approximately 10 cm., the chromatogram was dried in a stream of cold air, and treated with benzidine (Fig. 1). There was a marked lag in the elution of the spot, leaving an indentation in the advancing front. Only after the solvent front had moved two or three centimetres ahead of the spot did elution commence. In further experiments small quantities of bromphenol blue were added to the chromatogram on either side of the mid-line of flow of the protein (Fig. 2). Material from the sides of the spots was eluted first and occasionally caused the production of "two separate fractions inside the finger" as observed by Franklin and Quastel[3]. Thereafter, owing to the inward flow of the solvent across the front of the spot, the tails fused and material from the rear was continuously carried to the front of the moving protein mass.

It was therefore apparent that the relative positions of the components of a mixture are dependent on certain factors not necessarily functions of its complexity. The protein is first segregated radially through the spot during drying, followed by peripheral elution. Secondly, infiltration and elution of the central portion which afterwards overtakes the material initially eluted causes the relative final positions of the fractions eluted from the centre and periphery of the original spot to depend on the distance the solvent front has travelled. It will be noticed that towards the end of a run of 20 cm., the protein is located as an oval spot only about twice the length of the original. Paper electrophoresis[5,6] of various portions of spots run under such conditions showed that at no stage in the process was there a linear distribution of the various components, albumin and globulin bands appearing in the final electrophoresis patterns of all areas of the spot. If by adequate manipulation of the conditions an elongated spot does result from the first run, this is again securely bound to the paper during drying, so that the developing solution is held back by the dried spot but eventually bursts through after its freely moving front has by-passed the spot by about 15 mm. The elongated protein trace is thus disrupted into a number of fractions. As many as eighteen have been observed immediately after the spot has been wetted out, if bromphenol blue is added to the protein initially. As the solvent front progresses, the faster-moving portions at either side flow inwards across the front of the protein, compressing the effective length of the complex of small spots, causing them to coalesce. Thus, the number of separate spots appearing on the final chromatogram depends on: (*a*) the length of the first run, since this affects the length of the spot; and (*b*) the length of the second run, since fewer spots are observed when this run is protracted.

It is also possible to show that the fractionation produced during the second run is not dependent on the existence of separate protein species in discrete positions on the paper. Spots of serum of varying length but containing the same volume were placed on the starting line, and developed with an appropriate solvent. The results showed great similarity to those obtained after a two-dimensional run.

Certain poly-hydroxy emulsifying agents were shown by Franklin and Quastel[4] to have the effect of increasing the number of fractions into which serum could apparently be divided. Since little or no separation may occur in the first direction, any increase in fractionation must be looked for in the second. This effect is apparently due to the greater degree of wetting-out occurring in those systems containing both protein and surface-active agent. Experiments with 'Span 20', sodium alginate and 'Tween 85' showed that the separation into small fractions could take place before the solvent front had passed the protein. There was therefore no tendency for the solvents to flow inwards and recombine the fractions; hence the greater number of fractions observed at the end of a run. For a similar reason the protein stayed with the front and did not lag behind.

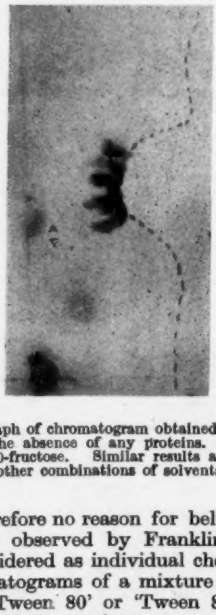

Fig. 3. Photograph of chromatogram obtained with 'Tween 80' and hæmin in the absence of any proteins. Solvent in both directions, *M*/100-fructose. Similar results are obtained with other combinations of solvents

There is therefore no reason for believing that the separate spots observed by Franklin and Quastel should be considered as individual chemical entities. Indeed, chromatograms of a mixture of the emulsifying agents 'Tween 80' or 'Tween 81' and hæmin without any protein produce an essentially similar pattern of spots (Fig. 3). Therefore, the inclusion of this type of compound may well increase the number of spots solely on its own account.

The conclusion to be drawn from this survey is as follows: during flow on a sheet of filter paper, the resistance of protein to transport in aqueous solution, coupled with the ease with which the solvent may by-pass the protein, will always tend to minimize the effectiveness of any possible separation of similar protein species.

The separation of proteins of quite dissimilar nature by this method, however, is, of course, perfectly practicable, as has been shown by Gross, Leblond, Franklin and Quastel[7]; but the patterns observed in complex mixtures such as serum are so dependent on the conditions of the experiment as to be pure

artefacts. Given adequate control, there is no doubt a good degree of reproducibility; but owing to differing interactions between various components of different mixtures, the patterns observed can have no direct correlation with the complexities of the mixture.

Since this work was completed, Swingle and Tiselius[8] have also expressed the opinion that the patterns observed under these conditions are artefacts dependent on the general properties of proteins in contact with paper; but owing to the fact that our observations may be of interest in further work on protein separation, we have felt it desirable that they should be placed on record.

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A technique for the two-dimensional chromatography of blood plasmas or protein mixtures on filter paper has been described by Franklin and Quastel[1] which differs in certain important respects from the well-known methods adopted in amino-acid paper chromatography. It was found that the additions of small quantities of surface active agents such as the 'Tweens' or 'Spans' seemed to facilitate the separation of plasma constituents and extend the protein 'pattern'. The technique adopted at present is to add 'Tween 85' or 'Tween 81' to the plasma and use hæmin as the protein marker. A mixture of an alcoholic solution of benzidine and hydrogen peroxide, made acid with acetic acid, is used for detecting the hæmin. Solutions of sucrose and of sodium potassium tartrate have been selected, after many experiments, as the most suitable developing solvents in the first and second dimensions respectively. The former solution appears to facilitate movement of certain protein hæmin complexes, as well as uncombined hæmin, in the first dimension; the latter solution allows movement of certain protein complexes in the second dimension while preventing movement of uncombined hæmin. There must not be overloading of the paper with protein; usually 0·02 ml. plasma is applied. The technique has been used in the study of blood plasma changes that occur consistently after heparin administration and after single high-fat meals[2] and in investigations of multiple sclerosis[3]. It has also been used profitably in an investigation of the combination between thyroxine and plasma constituents[4], in a study of the breakdown of casein by rennin and of the separation of rennin from crude rennet preparations[5], and in the demonstration of non-specific agglutinins for Brucella in bovine sera[11].

Drs. Hall and Wewalka point out that the upward flow of the plasma proteins from the original spot on the paper consists of a gradual elution by the ascending solvent and conclude "that the relative positions of the components of a mixture are dependent on certain factors not necessarily functions of its complexity". They also state, without giving the experimental evidence, that at no stage in the process is there a linear distribution of the various components, albumin and globulin bands appearing in the final electrophoresis patterns of all the areas of the spot (no surface-active agents were used). Thus, they intimate that no separation of protein constituents of the plasma takes place in the first-dimensional run. This conclusion leads them to imply that the fractionations seen in the second dimension are due simply to the mechanical or physical factors operating in this technique, and do not reflect any separations of a chemical nature. It is further claimed that the action of surface-active agents is only to prevent the coalescence of fractions which is observed in the second-dimensional run when no surface-active agent is present.

If these observations and conclusions are correct, it follows that the protein patterns of various plasmas should offer no great dissimilarities, since the patterns are allegedly not dependent on the chemical complexity of the plasmas but on the physical factors operating in the runs in the two dimensions.

Much experience has shown that the protein patterns obtained using our technique with normal plasmas are very similar to each other and may be reproduced with considerable regularity. On the other hand, the patterns obtained with many pathological plasmas differ very greatly from those given by the normal. These may also be duplicated with regularity in the same patient, so long as the clinical condition of the patient does not alter. There is now ample evidence which, it is hoped, will be published shortly, to show that the abnormal patterns observed in certain diseases revert to normal when the disease is successfully treated. Photographs of typical paper chromatograms of (*a*) normal plasma, (*b*) plasma of a patient suffering from cancer of the

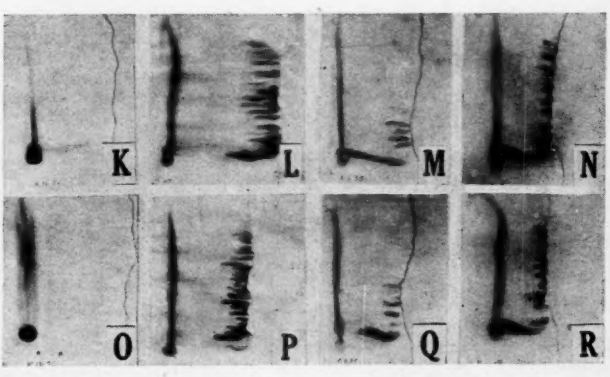

Fig. 1. *K*, Hæmin control (0·02 ml. of 0·3 per cent hæmin in 0·5 ml. of distilled water plus 0·02 ml. of 'Tween 81'); *L*, normal plasma (0·02 ml. of 0·3 per cent hæmin and 0·02 ml. of 'Tween 81' added per 0·5 ml. of plasma); *M*, plasma of a patient with cancer of the stomach (0·02 ml. of 0·3 per cent hæmin and 0·02 ml. of 'Tween 81' added per 0·5 ml. of plasma); *N*, plasma of a patient with lupus erythematosus (0·02 ml. of 0·3 per cent hæmin and 0·02 ml. of 'Tween 81' added per 0·5 ml. of plasma); *O*, same as *K* but with 0·01 ml. of 'Tween 85' instead of 'Tween 81' added per 0·5 ml. of plasma; *P*, same as *L* but with 0·01 ml. of 'Tween 85' instead of 'Tween 81' added per 0·5 ml. of plasma; *Q*, same as *M* but with 0·01 ml. of 'Tween 85' instead of 'Tween 81' added per 0·5 ml. of plasma; *R*, same as *N* but with 0·01 ml. of 'Tween 85' instead of 'Tween 81' added per 0·5 ml. of plasma

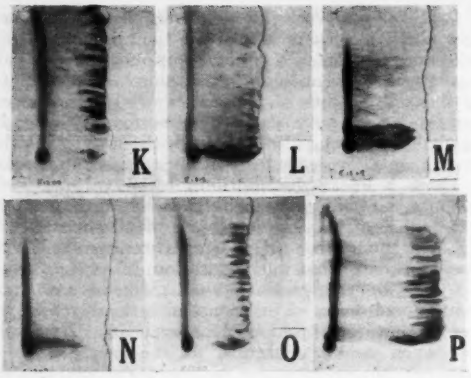

Fig. 2. *K*, Cohn fraction V (95 per cent albumin and 4 per cent α-globulin), 0·02 ml. of 0·3 per cent hæmin and 0·02 ml. of 'Tween 81' added to 0·5 ml. of a 6·5 per cent solution; *L*, Cohn fraction IV-4 (16 per cent albumin, 46 per cent α-globulin and 38 per cent β-globulin); experimental conditions as in *K*; *M*, Cohn fraction II (3 per cent β-globulin and 97 per cent γ-globulin); experimental conditions as in *K*; *N*, Cohn fraction I (7 per cent albumin, 8 per cent α-globulin, 15 per cent β-globulin, 9 per cent γ-globulin and 61 per cent fibrinogen); experimental conditions as in *K*; *O*, reconstituted plasma (3 per cent Cohn fraction V, 1·3 per cent Cohn fraction IV-4, 0·5 per cent Cohn fraction II, and 0·6 per cent Cohn fraction I in 0·85 per cent saline); experimental conditions as in *K*; *P*, normal human plasma; experimental conditions as in *K*

stomach, (*c*) plasma of a patient suffering from lupus erythematosus are shown in Fig. 1 (see also ref. 6, where further results are presented). These facts, pointing to extensive differences between the patterns of normal and pathological plasmas, make it obvious that the nature of the two-dimensional pattern must be a function of the chemical composition of the plasma.

That the physical factors operating in this form of paper chromatography help to determine the final pattern need scarcely be said, and this, it seems to us, is inevitable. But this fact does not justify the conclusion that the pattern does not reflect the chemical composition of the plasma or protein mixture. Moreover, no statement has been made in our publications that the fractions seen in the paper chromatograms of plasmas represent separate protein species.

Definite separations of proteins are practicable by this technique. For example, cytochrome *c* may be separated from serum albumin in a mixture of these substances[6]. The former moves but little in the first dimension and is easily taken into the second dimension, whereas the latter moves freely in the first dimension, to the head of the advancing front, and also moves easily in the second dimension. It can be shown (see Fig. 2) that widely different patterns occur with purified preparations of serum albumin, α- and β-globulins, γ-globulin and fibrinogen using our technique. Papastamatis and Wilkinson[7] have also recently demonstrated the different rates of movement of insulin, fibrinogen, γ-globulin and serum albumin, on filter paper using salt solutions as developing solvents.

The paper chromatogram of a mixture of serum albumin, serum globulins and fibrinogen in the proportions in which they are present in plasma gives a pattern very similar to that obtained with a normal plasma (see Fig. 2). This is a further indication that the chromatogram of a protein mixture is dependent on the chemical composition of its constituents.

Hæmin alone, in the absence of added proteins, under our experimental conditions gives but little movement in the second dimension, and this is negligible compared with the movement of the protein–hæmin complexes (see Fig. 1). Drs. Hall and Wewalka point out that movement of hæmin, in the absence of added proteins and in the presence of 'Tweens', does take place in the second dimension; but they use a fructose solution as developing agent in *both* dimensions. Naturally, in such circumstances, a movement in the second dimension will take place; but this is quite irrelevant since they do not use our developing solvent, which suppresses the movement in the second dimension.

Furthermore, Drs. Hall and Wewalka assert that the action of the surface-active agents is due to a 'wetting-out' phenomenon whereby the fractions obtained in the first direction are not allowed to coalesce in the second. Thus, the appearance of greater fractionation is observed. But this assertion does not take into account the fact that, in the absence of the surface-active agent, serum albumin will ascend wholly to the head of the paper, there to be separated into a few fractions in the second dimension[6], whereas in the presence of suitable quantities of a 'Tween' the rate of movement of the protein is depressed and a considerably lengthened spot is obtained in the first dimension, giving rise to an increased number of fractions. With a serum globulin, the presence of the 'Tween' may suppress all movement in the first dimension (see Fig. 2).

Combinations of detergent and enzyme proteins have been described[8] and it is known from the work of Putnam and Neurath[9] that albumins combine with surface-active agents such as the detergents to form complexes of various mole ratios. It is therefore likely that the elongation of the protein spot in the first dimension may be partly due to the different rates of solution of the surface-active agent – protein complexes and partly due to the varying affinities of these complexes for the cellulose of the paper. The increase, therefore, in the number of fractions is probably largely due to the formation of these complexes. There can be little doubt that complex formation between globulins and surface-active agents, such as 'Tweens', also occurs and that these complexes move with great difficulty in the first dimension under our experimental conditions. Use of other surface-active agents may provide for more effective separations of albumins and globulins than we have been able to obtain so far.

Further experiments[6] have shown that the admixture of γ-globulin to human plasma brings about a marked alteration of the pattern, a heavy basal fraction appearing when 'Tween' is used. The heavy fractions at the bottom of the pattern seem to be typical of the chromatograms obtained in plasmas of

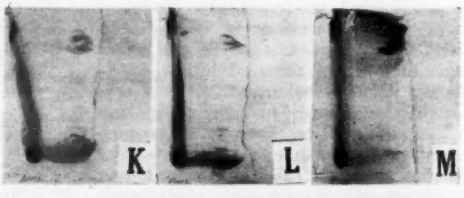

Fig. 3. Cobra venom: *K*, supplied by Haffkine Institute, Bombay; and *L*, supplied by Hynson, Westcott and Dunning, Inc., Baltimore, Md.; *M*, *Agkistrodon piscivorus* venom supplied by Ross Allen's Reptile Institute, Silver Springs, Florida

pathological cases where the globulin/albumin ratio has been increased. It has already been pointed out[1] that the chromatogram of the plasma of a horse immunized against diphtheria toxin (the plasma presumably having an increased globulin content) differs from that of normal horse plasma by the possession of extra fractions at the bottom.

The fact that protein mixtures of different chemical composition yield different patterns is also illustrated by the photographs given in Fig. 3. These show chromatograms of two different samples of cobra venom and of a sample of *Agkistrodon piscivorus* venom, the same quantity (0·8 mgm.) being taken, and no surface-active agents being present. It will be observed that the chromatograms of the two cobra venoms are very similar to each other but differ from that of the other venom.

It is difficult to reconcile two statements in Drs. Hall and Wewalka's communication, namely, "The separation of proteins of quite dissimilar nature by this method, however, is, of course, perfectly practicable", and "the patterns observed in complex mixtures such as serum are so dependent on the conditions of the experiment as to be pure artefacts". We readily agree that all patterns are dependent on the conditions of the experiment; but since separations of proteins admittedly do occur by this technique, the patterns cannot be regarded as solely dependent on the physical conditions and therefore as pure artefacts.

With reference to the suggestion of Swingle and Tiselius[10] that the chromatograms may be "artefacts", we are informed by Dr. Swingle[12] that the evidence referred to in their paper was rather circumstantial and did not seem to justify publication without additional experiments.

Further investigation, especially of a quantitative nature, is needed to decide the chemical nature of the fractions obtained in the second dimension, and such work is now in progress. But ignorance of this fact, at present, need not deter further development of the technique, which is obviously in an exploratory stage. It is possible that it will provide an inexpensive means of clinical aid both in diagnosis and in following treatment.

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July 17.

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ANNUAL EXHIBITION OF THE ROYAL PHOTOGRAPHIC SOCIETY, 1951

THE ninety-sixth annual exhibition of the Royal Photographic Society was opened in London on September 13 for one month and will also be shown at the City Art Gallery, Aberdeen, during November 3–24. The exhibition is divided into five groups: pictorial, record, Nature, medical and scientific photography, with a total of 908 exhibits.

The scientific entries constitute the smallest individual group; but medical and surgical entries are well represented. There is a collection of some nine full-sized radiographs in this latter section, one of which is very effectively shown as a two-colour radiograph by D. Stevenson Clark and entitled "Bas relief colour radiograph of right pneumothorax". This was prepared from the original radiograph by contact-printing a positive to give a magenta image and registering this with a solarized negative coloured cyan. One of the other monochrome radiographs, by R. M. Leman, was given a distinct relief effect presumably by the use of a slightly out of register negative mask, which resulted in a noteworthy emphasis of the arteries shown in this particular exhibit. Among the medical prints is one from Manchester Royal Infirmary, in which the arteries of a heart are well revealed by a radiograph made after injection of lead phosphate. Included in the several examples of ophthalmic photography are two, one by P. N. Cardew and the other by Miss A. E. Milne, in which an annular electronic flash tube was used to illuminate the eye. The reflexion of the tube itself by the outer surface of the cornea indicates whether any imperfections exist on this surface, these being revealed by distortion in the shape of the annulus. Two exhibits by D. M. Kermack showing stages in the dissection of a marine worm provide an illustration of how revealing and orderly a careful example of this type of work can be. A series of photomicrographs by G. C. Lenney on cell division in a mouse tumour must have caught the eye of any who have visited the Festival of Britain Science Exhibition, where a large section is devoted to cell division: in these photographs both normal double-cell division and abnormal multi-cellular division showing stickiness of the chromosomes are well shown.

The most interesting exhibits in the science section are those submitted by the National Physical Laboratory. In one of these there is an example of the use of the Linnick interference microscope, in which the relief effect shown on the surface of a photographic negative of a three-bar resolution test object is examined. Horizontally, the magnification is × 2,100; but by virtue of the optical interference shadows an effective vertical magnification of × 166,000 is achieved. The actual relief effect in the gelatin of the image under examination is seen to be almost one micron. The Laboratory also shows some examples of the *Schlieren* patterns produced by high-velocity air flow. Thus the air flow in the neighbourhood of a supersonic jet is shown, as are the pneumatic disturbances produced around an aerofoil at high subsonic and also supersonic speeds. The shock wave produced in the former case and the 'bow wave' in the latter are clearly indicated. By using the properties of polarized light, the degree of air compression in these waves can be assessed by

measurement of the interference colours, as is shown in a pair of colour transparencies. Brown–Firth Research Laboratories present what must have been a very difficult subject to photograph satisfactorily, namely, the surface of molten chromium–molybdenum steel at 1,600° C. in a Siemens open-hearth furnace. Several ordinary aerophotographs are shown; but there is no doubt that the stereo-viewing of this type of exhibit as shown by Hunting Aerosurveys, Ltd., is much more impressive, particularly to those unfamiliar with the viewing of this type of photograph. The exaggerated relief effect emphasizes even slight contours, and ordinary two-dimensional photographs of this type of subject seem all the flatter by comparison.

The photographic recording of a collection of examples of mechanical engineering submitted by H. C. Lane also illustrates the value of the stereoscopic record compared with that of the ordinary paper print, although it must be remembered that, in a series of this type, the stereophotographs, being transparencies, are likely to excel the prints in quality by virtue of their extended optical density-range quite apart from the three-dimensional effect. Among the more interesting record photographs must be mentioned those of Lost John's Cave, Lech Fell, Lancs, by J. Benjamin, who, with the aid of an illustrated plan, follows up several regions of this cave, which contains 4,000 yards of passages, by a series of photographs. In the record section, a Royal Photographic Society Medal has been awarded to J. H. Steer for his photograph of a "Tablet", and perhaps the "Chair Back" of Miss J. W. Robinson and the "Royal Festival Hall" by Miss Margaret Harker should also be mentioned among many fine examples.

The largest part of the section on Nature is devoted to pictures of birds, of which the owl seems to be the most popular. Special mention is due to W. E. Higham for a fine series of pictures entitled "Golden Eagle".

UNIVERSITY OF OXFORD

NEW DEPARTMENT OF BOTANY

THE new building of the Department of Botany in the University of Oxford was formally opened on October 8 by Lord Rothschild, chairman of the Agricultural Research Council.

The first professor of botany in the University was appointed by Charles II in 1669. The early teaching of the subject was associated with the Botanic Garden which had been founded in 1621, and buildings for the study of botany were erected during the seventeenth century just outside the Garden wall. Extensions were made to contain the library and herbarium of William Sherard as a condition of his endowment of the chair of botany; but these buildings were removed at the end of the eighteenth century and an orangery was used for housing the library and herbarium. This orangery was incorporated in the professor's house, built by Daubeny in 1836. Daubeny also built a lecture room which was joined to another orangery, altered to hold the Fielding Herbarium, presented to the University in 1851. These two orangeries within the Garden wall were the starting-points of the two separate buildings which, until now, have accommodated the Department of Botany. Further additions were made up to 1933 by new construction and by the lease of the adjacent laboratories of Magdalen College.

The history of the Department meant that its buildings were separated from the other scientific Departments of the University and were unsuitable for the modern study of botany. Soon after Prof. T. G. B. Osborn was appointed to the Sherardian chair in 1937, the University therefore decided to transfer the Department to a new building in the Museum area, although this meant separating it from the Botanic Garden. Sir Hubert Worthington was appointed as architect and the major plans were begun in 1939; but building was held up by the War.

The new building is situated on the south side of the University Parks, behind the Observatory and between the Departments of Pathology and Physical Chemistry. It is united to the new Imperial Forestry Institute by a lecture theatre. The building has a steel frame, reinforced concrete floors and exterior walls of Bladon and Clipsham stone. There are four floors with a total area of nearly 40,000 sq. ft. and the flat roof is available for experimental work.

The teaching of the Department is carried out in three laboratories for advanced study and one for elementary study. The elementary laboratory is designed for a class of 102 in a room that can be comfortably controlled by the demonstrator. There is a small lecture room as well as the large theatre shared with the Department of Forestry. Research is accommodated in large laboratories for plant physiology and mycology and others for ecology and cytogenetics. In addition to private laboratories for the staff, there is also a number of research rooms for one or two workers and rooms for special apparatus. All the main laboratories have their own ancillary rooms for preparing and storing material and apparatus. In one of the northern wings the Fielding Herbarium, the Druce Herbarium (which was formerly kept in its founder's house in north Oxford) and the Forest Botany Herbarium (which used to be kept in the old Imperial Forestry Institute) are collected into two large rooms. Another room contains a small museum and the ancient herbaria. The main store rooms in the basement are served by ramps from street-level and by a lift to all floors and the roof. The departmental library of some fifteen thousand volumes is housed mainly in two stack rooms, except for the collection of taxonomic works which is kept with the herbaria. The reading room contains the Sherard Library and other valuable old books in glass-fronted cases, and is attractively furnished in unstained oak. The furniture and fittings throughout the building have been designed for flexibility and economy in the use of space. Wall benches are supported on cantilevers wherever possible and cupboards and drawers are in interchangeable units. The main services are carried in flues; as well as gas, water and A.C. lighting and power lines, there are 100-volt and 6-volt D.C. circuits in most research rooms; compressed air and fresh air are piped to some benches.

A garden courtyard has been laid out between the new building and the Imperial Forestry Institute and there is a small plot on the north side and a greenhouse on the roof available for growing plants for experimental purposes. The Department will, of course, continue to depend upon the Botanic Garden for much of its material.

RESEARCH AND DEVELOPMENT IN BRITISH COLONIAL TERRITORIES

THE survey "The Colonial Territories (1950–51)"*, as in previous years, provides much of the background against which the value of the work of the Colonial Research Council and like bodies is best appreciated; the present report includes a chapter on research and surveys which summarizes progress reported more fully in "Colonial Research, 1950–51". Meanwhile, the establishment during the year of a Scientific Council for Africa South of the Sahara, which held its first meeting in Nairobi in November, is noted, and also the holding in June of a review conference to survey the work of the Commonwealth Agricultural Bureaux Organization. Progress in starting the work of the various Colonial fishery stations and institutes continues to be hampered by the shortage of qualified staff, and special stress is laid on the opening of the Sugar Technology Laboratory at the Imperial College of Tropical Agriculture. The Colonial Products Advisory Bureau completed ninety-five laboratory investigations and dealt with 672 inquiries. The year saw the formal opening on January 31 of the West African Institute for Trypanosomiasis Research, with laboratories and installations at Kadua and Vorn in Northern Nigeria. Construction of a central Trypanosomiasis Research Institute in East Africa has been agreed upon by the East African Governments and the Secretary of State for the Colonies, and it is expected that the whole of the capital expenditure and about 50 per cent of the recurrent expenditure for the first five years will be met from the Colonial Development and Welfare vote.

Although details of the actual scientific work are reserved for the report on "Colonial Research", major developments are appropriately reviewed in the wider context of the present report. This review thus helps to correct some of the criticism which is directed against British Colonial policy; that is also true of other activities of direct interest to the scientific worker which are recorded in the chapter on "The Social Services". Educational developments are discussed elsewhere, but reference may appropriately be made here to the developments recorded in mass education, which show how the organization of government is being adjusted to fit in with the new conception of community development, notably in Kenya, Uganda and West Africa. Where the formation of community development departments or appointment of community development officers has led to village communities being encouraged to co-operate in numerous small projects to prevent flooding or desiccation of the land, reclaim land, construct buildings, eradicate hookworm or roundworm, much has been done to improve the welfare of the community. Steady progress is reported in the medical and health services, and as general standards of public health improve it is becoming easier to select for attention in a particular territory those diseases which have the greatest social and economic significance. On January 1, 1951, there were, however, still 160 vacancies for medical practitioners in Colonial territories, the need being particularly urgent in West Africa and Malaya. The development of health centres in urban and rural areas is gaining in popularity and proving effective. The mobile maritime dispensary service in Sarawak was augmented, and marked success was achieved by the mobile health unit serving twenty-five villages in a remote part of Cyprus. Medical field units, or epidemic control units, which deal with endemic diseases of all kinds in their areas, and also when necessary with epidemics of smallpox, cerebro-spinal meningitis, relapsing fever and trypanosomiasis, have been evolved in West Africa from the former Sleeping Sickness Control Units, and their scope has recently been extended to include health surveys.

Arrangements were made during the year with the Pasteur Institute in Paris for freeze-dried B.C.G. vaccine to be supplied to all Colonial territories which require it, but much research is required before the value of universal B.C.G. vaccination can be finally assessed. On the whole, very satisfactory results have been obtained in the treatment of leprosy with sulphone preparations, particularly with diphenyl sulphone.

In the field of malaria, an international conference held in Uganda in November–December under the joint auspices of the World Health Organization and the Commission for Technical Co-operation in Africa made apparent the important contribution in research which could be made in British Colonial territories. At Ibaro in Nigeria the effect of residual spraying in a hyper-endemic area is being carefully studied; a campaign in British Honduras was intensified, when spraying of about 98 per cent of the dwelling houses in the Colony with an emulsion of DDT was completed, and the first phase of the Mauritius eradication scheme—spraying of houses with residual insecticide—was also completed during the year. Increased attention was given to the control of onchocerciasis in African territories—for example, by attacking the small biting fly (*Simulium*) which carries the disease—and it is hoped to eradicate the fly from that part of the Nile where work is in progress on the Uganda hydro-electric scheme by aerial spraying with DDT.

As regards subordinate staff, the main emphasis is still on the training of hospital assistants, male and female nurses, and health inspectors; but laboratory technicians and pharmacists are also being trained and the development of specialist services is accompanied by some specialization in training. Owing to staffing difficulties, Colonial territories could not take full advantage of the offer of the National Association for the Prevention of Tuberculosis, and only two of the six scholarships for training in tuberculosis work in Great Britain were awarded.

Organized efforts to improve nutrition are an essential part of the campaign for raising the level of health, and a feature of practical nutrition programmes is the increased use of food-yeast. Reference is also made in this report to the important part played by broadcasting in education and in assisting the understanding of public affairs, and to the invaluable work in these territories of the British Council. The dependence of social welfare and social services on economic development is made clear, and the report is as useful a contribution to the discussion of economic or political developments in these territories as it is to the consideration of the scientific or technical work which is reviewed more fully elsewhere.

* Colonial Office. The Colonial Territories (1950–51). (Cmd. 8243.) Pp. ix+184. (London: H.M. Stationery Office, 1951.) 4s. 6d. net.

LETTERS TO THE EDITORS

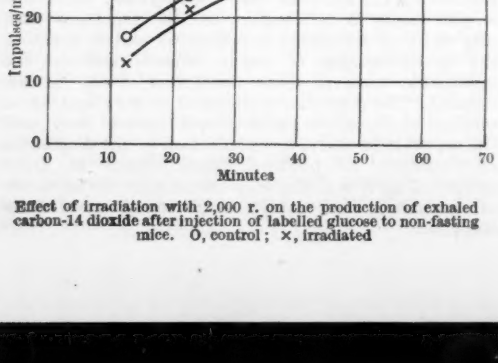
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Effect of Irradiation by X-Rays on the Exhalation of Carbon Dioxide by the Mouse

It has been shown previously that the rate of formation of deoxyribonucleic acid is depressed by a sublethal dose of X-rays. Both the incorporation of phosphorus-32 [1-5] and that of carbon-14 [6,7] was found to be reduced about 50 per cent. The rate of incorporation of carbon-14 into the purines of ribonucleic acid is reduced as well[7], though to a smaller extent than its incorporation into the purines of deoxyribonucleic acid. These blocking effects are presumably due to inactivation of enzymes involved in the synthesis of the deoxyribonucleic acid and ribonucleic acid compounds. One or a few days after irradiation, the incorporation of carbon-14 into purines of deoxyribonucleic acid has nearly returned to the rate for the non-irradiated controls. This suggests that a partial reactivation has occurred. The early metabolic changes produced by irradiation are not confined to interference with nucleic acid synthesis. We find that irradiation interferes with glucose metabolism as well.

Fully grown mice which had been fed *ad libitum* were placed in perforated metal boxes which prevented gross movement. In each experiment four such boxes were symmetrically placed in a metal cylinder containing carbon dioxide-free air and kept at 27°. Exhaled carbon dioxide was swept from the brass cylinder by carbon dioxide-free air at constant velocity and collected in a series of three wash-bottles containing barium hydroxide. At intervals of 10 min. the air stream was switched over to another aggregate of wash-bottles. The carbon dioxide was collected for one hour.

Glucose (60 γ having an activity of 0·03 μC.) labelled in all its carbon atoms was injected subcutaneously into each mouse immediately after irradiation. Collection of carbon dioxide started 8 min. after injection. The increase in weight of barium carbonate with increasing time shown in the graph has no significance, as it is a result of the fact that the content of exhaled carbon dioxide in the metal cylinder increases with time. We wished only to determine the ratio of carbon dioxide exhaled by irradiated and control mice, not the total amount exhaled.



Effect of irradiation with 2,000 r. on the production of exhaled carbon-14 dioxide after injection of labelled glucose to non-fasting mice. O, control; ×, irradiated

We found that the non-fasting irradiated mice exhale only some 80 per cent of the amount of carbon dioxide exhaled by control mice. This result does not necessarily prove an impaired catabolism of body glucose. Since only about one-half of the exhaled carbon dioxide originates from catabolism of glucose[8], the other half having its origin in catabolism of fatty acids and other body constituents, it may be that the catabolism of the last-mentioned compounds and not that of glucose is responsible for the reduced exhalation of carbon dioxide by the irradiated mouse. The fact, however, that if labelled glucose is administered the irradiated mice exhale a smaller amount of carbon-14 labelled carbon dioxide than the controls proves unambiguously that irradiation depresses the glucose catabolism of irradiated mice. The graph indicates that the depression is already apparent after the lapse of 8 min. and may possibly be still more pronounced at an earlier time.

It is of interest to note that Lourau and Lartigue observed that addition of glucose to the diet of the guinea pig increases its radiosensitivity[9], that irradiation with 500 r. produces hyperglycæmia in the irradiated animal[10] and, quite recently, that 12–15 days after irradiation glycogen formation in the liver is reduced 1–2 hr. after feeding glucose[11].

The reduced catabolism of glucose in the irradiated mouse is reflected in an increase of forty to one hundred per cent in the carbon-14 content of liver fats.

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The Philippine Trench and its Bottom Fauna

Very little is known about animal life in the greatest ocean depths; only two previous hauls seem to have been made below 6,000 metres. In 1899 the U.S. Fish Commission steamer *Albatross* obtained siliceous sponges in the Tonga Trench at 4,173 fm. or 7,632 metres[1]. A similar deep haul was not made until 1948 when the Swedish Deep Sea Expedition trawled holothurians, a fragment of a polychæte, an isopod and a few amphipods in the Porto Rico

Trench at depths between 7,625 and 7,900 metres[2]. I can now report that in July the Danish Deep Sea Expedition of 1950–52 in the research ship *Galathea* obtained living animals of several phyla from a depth of greater than 10,000 metres in the Philippine Trench, more than 2,000 metres below previous known occurrences.

The Philippine Trench is considered to be the deepest area of the oceans of the world. The area of the Trench at 10,000 metres or more was readily delimited with the supersonic echo sounder on board the *Galathea*. Although no real survey of the Trench was aimed at, the soundings necessary for the biological work indicate a continuous area between 9° 04′ N., 127° 05′ E., and 10° 41·3′ N., 126° 37′ E., that is, about a hundred nautical miles long, while the width probably never exceeded about two nautical miles. The greatest depth was found to be 10,540 metres, corrected according to Matthews[3]. This was recorded on July 23, 1951, at 12.50 hr. at 10° 23·8′ N., 126° 40·5′ E. The depth of 10,800 metres recorded by the German cruiser *Emden* was sought for in vain; our soundings were in general agreement, however, with those of the Dutch research ship *Willebrord Snellius* and the U.S.S. *Cape Johnson*, the last-named of which recorded a maximum depth of 10,497 metres[4]. The general direction of the bottom area was about 340°, thus pointing about 20° W. of north. The bottom itself is very even, consisting of a very fine clay with an admixture of sand, small stones, vegetable debris and chitinous remnants of terrestrial insects. A sample of 26 litres was taken with the 0·2-sq. m. Petersen grab from 10,395 metres, besides two cores 75 cm. long with the Kullenberg corer. The temperature at 10,123 metres was 2·56° C., while the minimum temperature of 1·59° C. was found at 3,500 metres.

A three-metre wide sledge trawl of the Agassiz type brought up in the first haul from 10,462 m. an abundance of clay with several stones. The first animal seen was a small white actinian attached to a stone; further search gave altogether some twenty-seven actinians, seventy-five holothurians (*Myriotrochus* sp.), five bivalves (*Portlandia* ?) and one amphipod. The Petersen grab contained one specimen of the same species of *Myriotrochus*. The total result obtained, including one haul with the sledge trawl from 10,417–10,484 m. and another from 10,026 m., was about forty actinians, five echiurid worms, eighty *Myriotrochus*, one elasipod holothurian, five bivalves (*Portlandia* ?), one of each of two species of amphipods and one well-preserved specimen and three fragments of two species of tanaïds. This gives altogether nine species, to which undoubtedly more could have been added. But two typhoons passing north of the area made further operations impossible. The skilful manœuvring of the ship, commanded by Captain Sv. Greve, R.D.N., and the very special equipment for deep-sea trawling, were decisive for the positive results. Trawling in other trenches and deeps will be tried in the near future to add material for comparison.

Prof. Claude E. ZoBell, of the Scripps Institute, University of California, has secured live samples of bacteria from the bottom deposits and is keeping cultures on board under his special high-pressure technique.

The proof that a variety of animals have been adapted to life under a pressure of more than 1,000 atmospheres must lead to a renewed consideration of many problems in physiology and biochemistry. The living bacteria may yield valuable material for experiments to solve them.

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Composition and Structure of Yeast Cell Walls

IN a study of the structure of the cell wall of baker's yeast with the electron microscope, one of us (A. L. H.) obtained results which induced us to start microchemical work on the presence of chitin (P. A. R.) and to study X-ray diffraction of the cell walls (D. R. K.).

In baker's yeast the main cell-wall material, which remains after successive treatments with dilute alkali and acid, is a glucan[1–4] with links of the 1 : 3 and 1 : 2 β-type. Cellulose has not been found in the cell walls of yeast.

The presence of chitin in several species of yeast has been claimed on the grounds of both the isolation of glucosamin and the chitosan iodine test[5,6]. So far as the Endomycetaceæ is concerned, this has been corroborated by X-ray diffraction; but in other yeasts, including *Saccharomyces cerevisiæ*, no chitin could be detected with this method[7].

In purified cell-wall material from baker's yeast a small amount, ± 0·5 per cent, of nitrogen has been found[1,2,4], which has been interpreted as an impurity. However, the amount is sufficient to account for an admixture of chitin up to ± 7 per cent. In fact, I. Hoette[8] obtained chitosan sulphate crystals from many species of yeast, including *Saccharomyces cerevisiæ*. Although in several species the crystals could not be obtained, chitin was supposed to occur in all of them but in varying and sometimes non-demonstrable amounts.

As to our microchemical work, we could mainly confirm Hoette's conclusions, since chitosan sulphate crystals could be obtained from baker's yeast and from all yeasts tested, including some species which had given negative results in Hoette's experiments. So far, we have encountered only one possible exception. In addition, our results suggest that the amount of chitin in yeasts may increase with the age of the cultures.

On electron micrographs cell walls freed from cytoplasm and cell inclusions by grinding, washing and centrifugation generally appear smooth and without a clear structure. After boiling in dilute alkali, a network of thin fibrils is discernible locally, especially in scars from buds. They seem to be embedded in non-fibrillar material. After subsequent boiling in 2 per cent hydrochloric acid a very striking, coarse network of aggregates of rather short fibrils is shown.

These changes are reflected in the degree of crystallinity as deduced from X-ray diagrams. Native cell-wall material, obtained as mentioned above, generally produces three to four broad and partly weak diffuse rings.

After the alkali treatment the diffuse rings become stronger. In yeast species sufficiently rich in chitin,

there appear in addition one or two sharper interferences corresponding to the strongest chitin lines.

After the subsequent acid treatment, all interferences become more intense and the diffuse rings are partly resolved into several sharper lines.

With cold 30 per cent hydrochloric acid the chitin could be extracted selectively; this treatment caused the chitin lines to disappear, but left the pattern of other lines unchanged. It does not effect any visible change in the electron micrograph.

There is little doubt that we have obtained the submicroscopic picture and the X-ray powder diagram of the insoluble yeast glucan mentioned earlier. Apparently, in the native membrane the substance is mainly amorphous, or possibly forms part of an amorphous complex of cell-wall constituents linked by easily hydrolysable bonds.

Details of our investigation will be published elsewhere[9].

The work has been supported by the Netherlands Organization for Pure Research (Z.W.O.).

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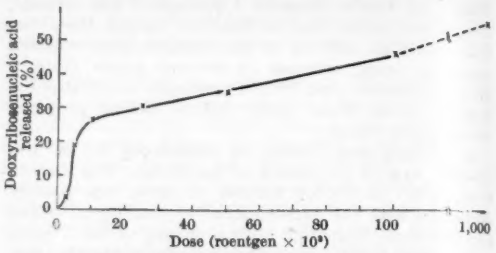
Effects of Ionizing Radiations upon Isolated Deoxyribosenucleoprotein Fibres

Changes in chemical and physical chemical characteristics of deoxyribosenucleoprotein and deoxyribosenucleic acid in solution following exposure to ionizing radiations have been described by several investigators[1-3]. Decreased viscosity and chemical decomposition have been reported.

Recently, we have carried out similar experiments using deoxyribosenucleoprotein in fibrous form and have found marked changes at relatively low radiation dosages.

Deoxyribosenucleoprotein was prepared from rabbit liver and calf thymus following the method of Petermann and Lamb[4]. Immediately prior to irradiation, the protein solution in 1 *M* sodium chloride was diluted with 6 volumes of distilled water at *p*H 6·8, producing the characteristic fibres; these, now suspended in 0·9 per cent sodium chloride solution, were subjected to ionizing radiation produced by a stream of electrons from an 800-kV. peak, resonance-transformer type cathode-ray machine. The control samples were prepared in identical fashion.

Following irradiation, the samples were centrifuged for 10 min. at 5,000 r.p.m. The clear supernatant fluid was assayed for nucleic acid by ultra-violet absorption at 2600 A. in a Beckman spectrophotometer, for deoxyribosenucleic acid by the Stumpf colorimetric test[5] and for protein by a quantitative biuret test[6].



Production of soluble deoxyribosenucleic acid by ionizing fibres of deoxyribosenucleic protein at *p*H 6·85

It was found that, following irradiation, variable amounts of nucleic acid had gone into solution (see graph). The biuret tests for proteins in the supernatants were negative.

No significant change in this effect was observed by varying the hydrogen ion concentration from *p*H 5 to *p*H 8. The addition of 0·005 *M* hydrogen peroxide to the deoxyribosenucleoprotein in *M* sodium chloride instead of the distilled water produced no change without irradiation; and subsequent exposure of this mixture to ionizing radiation was followed by changes identical with those without hydrogen peroxide.

In another experiment, deoxyribosenucleoprotein fibres were frozen at −20° C. during exposure. This procedure appeared to protect the fibres, since no deoxyribosenucleic acid was found in the supernatant fluid, indicating that the above-mentioned process takes place as the result of a chemical or 'indirect' reaction.

From these observations it appears that an important change occurs in the deoxyribosenucleoprotein fibres as a result of exposure to ionizing radiations. This decomposition may be related to the chromosome changes seen in cell nuclei following similar exposures.

Because of the radiomimetic action of the nitrogen mustards, we placed deoxyribosenucleoprotein fibres in varying concentrations (0·00064–0·0000064 *M*) of methyl *bis* (β-chloroethyl) amine hydrochloride, but found no evidence of decomposition even after allowing the fibres to remain in these solutions for 18 hr.

We are now carrying out experiments designed to study the effect of lowered oxygen tension, reducing agents and other chemical compounds upon the decomposition of the deoxyribosenucleoprotein fibres; we shall report detailed findings elsewhere.

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Nature of the Striated Muscle Fibre Membrane

At the present time, considerable confusion exists as to what should properly be called the sarcolemma, or true muscle fibre membrane. Long[1] defined the sarcolemma as a bipartite structure consisting of an inner layer, the true plasma membrane, and an outer layer composed of reticular fibrils. Meyer and Bernfeld[2] concluded that the sarcolemma is a collagenous-type protein. Jones and Barer[3] failed to find evidence of a collagenous or fibrillar structure.

Cytochemical tests have been carried out on the sarcolemma of isolated muscle fibres of the frog, *Rana pipiens*. In the process of teasing out fibres from various leg muscles, retraction clots were formed in the protoplasm. These clots shrank away from the sarcolemma, thus exposing large areas of the free membrane. The Withrow Morse[4] test for collagen was applied to fifty muscle fibre fragments as well as to entire muscle and bundles of fibres. The sarcolemma in the isolated fibre fragments invariably gave a negative response for collagen. In the whole muscles and bundles a positive reaction was obtained. In the second test for collagen (Chittenden[5]) muscles were boiled in a solution containing dilute sodium hydroxide and nitric acid. Numerous wrinkles, crevices, and folded edges appeared in the sarcolemma. The latter appeared to be festooned along the outer edges of the fibre. These festoon-like areas probably resulted from the swelling effect of the dilute acid. The third test, that of Barer[6], involved digestion of the fibre material in a 0·15 per cent solution of crystalline trypsin at *p*H 7·8. As a control, ligaments, tendons and other collagenous tissue were used. After digestion for four hours the sarcolemma had ruptured and gone into solution. The control tissues were unaffected by trypsin, even after eight hours in the enzyme solution. The xanthoproteic and ninhydrin reactions for protein were applied to the sarcolemma. A positive result was obtained in both tests. In the xanthoproteic reaction, the colour intensity of the sarcolemma decreased as the concentration of the nitric acid was lowered. Lipids were tested for by means of nile blue sulphate and sudan III dyes, with alcohol–ether extracted fibres serving as controls. Positive tests for lipid in the sarcolemma were indicated in both cases.

Bairata[7] regards the sarcolemma as a network of collagen fibres imbedded in a homogeneous colloidal matrix. He states that he has seen fine fibrils within the sarcolemma under polarized light and dark-ground illumination. This could not be substantiated here, nor could fibrils be seen using a phase-contrast microscope. What Bairata possibly considered a collagenous network in the membrane may in reality be the areolar connective tissue investing the individual fibre. Meyer and Bernfeld[2], using the dye methyl red, and Reed and Rudall[8], using the electron microscope, appear to have demonstrated the presence of collagen in the sarcolemma. The latter authors were able to demonstrate collagen fibrils; however, when the optical level of the true sarcolemma was reached, they found it to have a dotted, rather than a fibrillar, make-up. Barer[6] attempted to digest isolated portions of sarcolemma with the enzymes hyaluronidase and collagenase, but without any obvious effects. Jones and Barer[3] failed to find any evidence of a collagenous or fibrillar structure. They found, as did Reed and Rudall, numerous small dots present within the sarcolemma.

Typically, in the present investigation, a positive reaction for collagen in the sarcolemma was always obtained when whole muscle or bundles of fibres were used. When individual fibres, free of endomysium and other connective tissue, were tested, collagen was invariably absent. Furthermore, the sarcolemma always gave positive tests for protein. Unlike collagen, it proved digestible by trypsin. These facts, together with the positive reactions for the presence of lipids, suggest that the sarcolemma is a protein, possibly a lipoprotein. This type of chemical constitution is in agreement with that of the classical object of plasma membrane chemistry, the mammalian erythrocyte envelope.

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Transamination in the Human Tooth

In previous communications[1,2] it was shown that the presence of free aspartic and glutamic acids could be demonstrated in carious but not in sound dentine. With the view that a knowledge of the metabolic processes in the sound tooth might aid in an understanding of the caries process, it was decided to investigate whether the sound dental tissues exhibited any enzymatic activity towards aspartic and glutamic acids as substrates.

Using a paper chromatographic method[3], it has been demonstrated that a transaminase occurs in the human tooth in dentine and pulp tissue. This enzyme catalyses the reaction:

$$\text{L(}-\text{) aspartate} + \alpha\text{-ketoglutarate} \rightleftharpoons \text{L(}+\text{) glutamate} + \text{oxalacetate} \quad \ldots \quad (1)$$

Weaker activity was also demonstrated for the reaction:

$$\text{L(}+\text{) alanine} + \alpha\text{-ketoglutarate} \rightleftharpoons \text{L(}+\text{) glutamate} + \text{pyruvate} \quad \ldots \quad (2)$$

Owing to the very real technical difficulties involved in working with such small amounts of starting material, it has not been possible as yet to isolate relatively pure active preparations of the enzymes. However, anaerobic incubations using crude extracts and tissue suspensions have been made, and preliminary quantitative studies carried out successfully. The optimum *p*H for reaction 1 is 7·5 and Q_t values for pulp tissue are in the order of 10–12. Studies on the rate of glutamic acid formation, compared with the associated aspartic acid decrease, indicate a greater formation of the former than can be accounted for by loss of aspartic acid. This problem is at present under investigation.

Fuller accounts of this work will be published elsewhere.

Our thanks are due to Prof. E. Matthews, in whose Department the work is being carried out, for help and advice.

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Amino-acid Composition of Crotoxin

The first snake-venom prepared in the pure crystalline form was crotoxin from *Crotalus terr. terr.* as described in 1938; at that time only its cystine and methionine contents were quantitatively determined[1]. This protein, with a molecular weight of 30,000[2], proved to be homogeneous[3] in the ultracentrifuge[3] as well as by electrophoresis[4].

We hydrolysed each time 10 mgm. recrystallized crotoxin in 10 ml. of 6 *N* hydrochloric acid (five times redistilled) for 18 hr. at 120° in closed glass tubes. After removal of the acid in the usual manner, the mixture of amino-acids was analysed by paper chromatography.

The two-dimensional chromatogram on Whatman paper No. 1 with *n*-butanol + acetic acid (40 vol. *n*-butanol, 10 vol. glacial acetic acid, 50 vol. water) in the first, and phenol saturated with water at room temperature in the second, dimension is shown in the accompanying figure.

The following amino-acids could be identified:

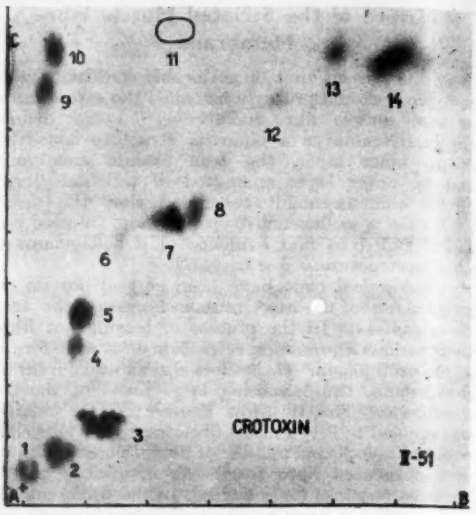
(1) Cystine	(8) Tyrosine
(2) Aspartic acid	(9) Lysine
(3) Glutamic acid	(10) Arginine
(4) Serine	(11) Proline
(5) Glycine	(12) Valine + methionine
(6) Threonine	(13) Phenylalanine
(7) Alanine	(14) Leucine + *iso*leucine

The identification of these amino-acids was checked by control experiments with mixtures of pure amino-acids under identical conditions.

It is known that valine + methionine (12) and leucine + *iso*leucine (14), when using the above-mentioned solvents, do not separate in the chromatogram. We therefore carried out two parallel one-dimensional chromatograms at *p*H 8·4 with *m*-cresol[5]: one with the crotoxin hydrolysate, the other with a mixture of pure valine and methionine. This showed clearly that valine as well as methionine are present in the hydrolysate.

Two one-dimensional chromatograms in *n*-butanol + benzylalcohol[5] run in parallel, one with a mixture of leucine and *iso*leucine, showed that these two amino-acids are both present in the hydrolysate.

The determination of histidine proved difficult at first. Although we could detect traces of a colour spot with ninhydrin in a one-dimensional chromatogram on Whatman paper No. 1 (using the *n*-butanol — acetic acid mixture), no sign of this amino-acid appeared in the two-dimensional chromatogram (see figure). We therefore ran another one-dimensional chromatograph, on Whatman paper No. 3, which



Hydrolysate of 350 μgm. crotoxin applied at +. Run with butanol + acetic acid in direction $A \rightarrow B$, then in direction $A \rightarrow C$ with phenol in an ammonia atmosphere; Whatman paper No. 1

makes it possible to apply larger amounts of hydrolysate and still obtain a good separation.

The existence of a small quantity of histidine in the crotoxin was proved by the following procedure: two chromatograms of the hydrolysate were run under identical conditions and developed, one with ninhydrin, the other with consecutive sprays of sodium carbonate and diazotized sulphanilic acid solutions. By means of this reaction (Pauly), the two red spots characteristic of histidine and tyrosine were found.

To detect hydroxyproline, one-dimensional chromatograms of hydrolysates of 100–200 μgm. crotoxin in buffered *m*-cresol were run on Whatman paper No. 1 and 3; neither with ninhydrin nor with isatin[6] were we able to detect any trace of hydroxyproline. From the molecular weight of 30,000 [2] it can be computed that, if only one molecule of hydroxyproline is included in the crotoxin molecule, hydroxyproline would represent 0·4 per cent of the crotoxin. But even with amounts of hydrolysate corresponding to 1,000 μgm. of crotoxin on Whatman paper No. 3, it was not possible to detect any trace of hydroxyproline, either with ninhydrin or isatin, although control experiments showed that 3–4 μgm. hydroxyproline are easily made visible in this way.

As tryptophan had already been determined in crotoxin[7], we did not examine any alkaline hydrolysate.

A recently published paper[8] describes the electrophoretic separation of the neurotoxic part of the venom of *Crotalus terr. terr.* By hydrolysation and two-dimensional paper chromatography, the presence of fifteen amino-acids was established; the results differ from ours in that arginine, histidine and valine were not found.

Summarizing our results we can now assert, beyond any doubt, that crotoxin contains the following eighteen amino-acids: arginine, histidine, lysine; aspartic and glutamic acid; phenylalanine, tryptophan, tyrosine; glycine, alanine, valine; leucine, *iso*leucine; proline; serine, threonine; cystine, methionine.

We are indebted to the Instituto Pinheiros, São Paulo, which generously provided crude rattle-snake venom for our experiments.

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Tyrosinase and Polyphenoloxidase; the Role of Metallic Ions in Melanogenesis

Some years ago it was suggested that the first step in melanogenesis, the oxidation of tyrosine to *o*-dihydroxyphenylalanine, can be represented by the following general reactions:

(1) *o*-dihydroxyphenol → *o*-quinone → intermediate products → melanin;

(2) *o*-quinone + monohydroxyphenol + H_2O = 2 *o*-dihydroxyphenol;

and that of these reactions only the first is really enzymic[1].

The apparent different specificity of enzymes of animal and of vegetable origin towards monohydroxy- and *o*-dihydroxy-phenols has led me to re-examine the possible role of metallic ions in the enzymic oxidation of *o*-dihydroxyphenylalanine and of tyrosine.

In this work the copper-free protein of potato-polyphenoloxidase was used, prepared in a manner similar to that described recently[2]. The total reaction volume in each Warburg flask was 2·5 ml.; this included 0·25 ml. of enzyme (corresponding to 15 enzyme units as defined by Lerner *et al.*[3]), varying amounts of metals (between 0·00005 and 0·0016 millimol. in presence of phosphate, and between 0·00005 and 0·02 millimol. in presence of citrate buffer) and the substrates (in side-arms).

I found, in agreement with Kubowitz[4] and with Keilin and Mann[5], that copper is strictly specific and cannot be replaced by any other metal as the prosthetic group of the enzyme. Once the enzyme is saturated by the relatively small amount of copper which it requires, it becomes fully active towards catechol and *o*-dihydroxyphenylalanine (reaction 1), and this activity cannot be augmented by excess of copper or of any other metal. However, I found that reaction 2 between *o*-quinone and tyrosine, that is, the oxidation of tyrosine, is catalysed by free and non-protein-bound metallic ions. Here, there is very little specificity: cobalt, nickel, vanadium and copper are all active, though copper is about 2·5 times as active as the other three. Iron, zinc, chromium, manganese and magnesium are inactive. Vitamin B_{12} appears to be inactive, or not more active than the cobalt which it contains, although physiologically it seems to participate in tyrosine metabolism[6]. Cytochrome *c* is not only inactive but also it inhibits slightly reaction 2. It is interesting to note the complete inactivity, in both *o*-dihydroxyphenylalanine and tyrosine oxidation, of zinc, which catalyses specifically the reaction 2-carboxy-2,3-dihydroindole-5,6-quinone → 5,6-dihydroxyindole[7]; the formation of these compounds thus appears even more problematical, or can only be of secondary importance, in melanogenesis[8].

Effect of Metals on the Rate of Oxidation of *o*-Dihydroxyphenylalanine (Dopa) and of Tyrosine

Molar concentration	Time (min.) required for half-oxidation of 1 mgm. Dopa	Time (min.) required for half-oxidation of 0·90 mgm. tyrosine + 0·05 mgm. Dopa
0·00002 Cu	9	180
0·001 Cu + 0·00002 Cu	9	49
0·001 Ni + 0·00002 Cu	9	95
0·001 Co + 0·00002 Cu	9	102
0·001 V + 0·00002 Cu	9	109

Although the transformation of tyrosinase in polyphenoloxidase during the purification process has been known for a long time and has given rise to much theorizing[3], this is the first time, so far as I know, that polyphenoloxidase has been transformed into tyrosinase.

Tyrosinase corresponds to the system polyphenoloxidase + *o*-quinone + metallic ions, the latter functioning probably as electron transmitters in the non-enzymatic reaction between tyrosine and *o*-quinone. Consequently it is difficult to see any justification for retaining the term 'tyrosinase', except as a reminder of the fundamental researches of G. Bertrand and H. S. Raper.

Details of this work will be published elsewhere.

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Fertilizing Capacity of Spermatozoa deposited into the Fallopian Tubes

In the natural sequence of mammalian fertilization, the spermatozoa await the arrival of ova in the Fallopian tubes. The time of waiting may vary from 6 hr. (rabbit), 24 hr. (ferret), 20–30 hr. (pig, sheep and cattle) up to perhaps several months (bat)[1]. Since the transportation of sperm from the vagina to the upper part of the tube is very rapid (a few minutes to 6 hr.[1]), and since the number of spermatozoa present at the site of fertilization is very small[1], this time interval is not necessarily for the accumulation of a large number of spermatozoa to ensure fertilization. The following experiment demonstrates that such a period of time in the female tract is required for the spermatozoa to acquire their fertilizing capacity.

Doe rabbits were injected intravenously with sheep pituitary extract to induce ovulation, which occurs about ten hours later. Ejaculated sperm collected with an artificial vagina was diluted about 1 : 10 with Ringer solution containing penicillin. At

various intervals before or after ovulation, four to six does were operated on under ether or nembutal anæsthesia. Flank incisions were made, and about 0·03–0·05 ml. of sperm suspension (0·2–1 million of spermatozoa) was deposited into the upper part of each tube through the infundibulum. Care was taken to avoid injury of the tube and the connective tissues. The animals were sacrificed 36–42 hr. after operation. The ova were recovered from the tubes and examined immediately under stereoscopic and compound microscopes. Only regularly cleaved ova, very often with sperm in the zona pellucida or in the perivitalline space, were regarded as fertilized. The results are presented in the accompanying table.

Fertilizing Capacity of Rabbit Spermatozoa deposited into the Fallopian Tubes at Various Intervals

Tubal insemin. Hr. before (+) or after (−) ovulation		No. of rabbits	Ovulation points	Ova recovered	
				Total	Per cent fertilized
	−2	5	58	40	0
	−1	2	14	10	0
	+2	5	42	31	0
	+4	5	39	34	6
	+6	4	49	41	78
	+8	5	50	47	55
Controls (mating)	−2	2	20	14	43
	+2	1	13	13	100
Controls (uterine sperm)	−2	2	20	15	13
	+2	2	13	12	75

It is quite clear that fertilization occurs when the spermatozoa have been in the tube for six hours before ovulation, which is perhaps the time required for a physiological change in the spermatozoa enabling them to attain fertilizing capacity.

Sperm were observed in the albumen coat of unfertilized ova following tubal insemination shortly before ovulation. Lack of fertilization from tubal inseminations two hours before or after ovulation was not due to a substance in seminal plasma harmful to the ova[2]. When epididymal sperm were employed (one animal in each group) similar results were obtained. Nor was it due to such a substance in the sperm, or to the harmful effects of operational procedures. Control experiments were performed in which tubal insemination, two hours before or after ovulation, was made to does mated with fertile bucks; all control females had ova fertilized.

Fertilization by sperm deposited into the tube two hours before or after ovulation was, however, obtained when the sperm used had previously been incubated in the uterus of another doe. The semen used in this experiment had been recovered five hours after injection into the œstrous uterus.

Hammond[3] has estimated the period for which the ovum remains capable of being fertilized. He obtained an average litter size of 0·2 young from does mated two hours after ovulation. Assuming four hours for transport of sperm, he concluded that fertility of the ovum after ovulation lasted about six hours at the most.

If this estimate is accepted, it would seem that lack of fertility from tubal insemination four hours before ovulation (or later) was due to loss of fertility in the ova before it was gained in the sperm. It may be, indeed, that the time needed for sperm transport is less than four hours and hence, possibly, the maximum duration of fertility of the ovum is also less. If so, sperm deposited in the vagina in Hammond's experiment must, in passing through cervix and uterus, have acquired fertilizing capacity more rapidly than sperm placed, in the present experiment, directly into the Fallopian tube.

On the other hand, if those sperm required six hours to develop fertilizing capacity, the estimate of duration of fertility in the ovum has to be slightly extended. Another possibility is that sperm are 'activated' in the œstrous uterus, but not when that organ comes under the influence of progesterone.

Fertilized rabbit ova[4] and normal pregnancy of mice[5] were observed when sperm was deposited into the tubes. So far as I am aware, no previous experiment for determining the time relationship between the deposition of sperm and ovulation has been reported. The metabolism of epididymal spermatozoa differs from that of ejaculated spermatozoa[6], demonstrating an influence of environment on the physiology of sperm. The present finding indicates a possible physiological change of spermatozoa in the female tract; this may also explain the lack of success of attempts to fertilize mammalian ova *in vitro* with ejaculated or epididymal sperm. Further study may explain aspects of sterility due to incompatibility between the environment of the female tract and spermatozoa.

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Birth Coats of Australian Merino Lambs

With one exception, little attention appears to have been paid to the birth coats of lambs, despite the great variability which exists and their potential value in selection in practical animal breeding. The exception is the work initiated by Dry[1,2] with the Romney Marsh breed in New Zealand.

Using the South Australian (Bungaree) merino, observations on birth coats were commenced at this College in 1944. Initially the investigation comprised two phases: (*a*) the genetic background of the birth-coat differences, and (*b*) the use of birth-coat characters as an indicator of adult fleece characters. During the past two years, an additional phase has been added, namely, the gross morphology of the fibre types and their relationship to the series of grades used.

Grading is based on the nature of the coat over the lumbar and sacral regions, and is carried out when lambs are 1–4 weeks of age. For recording purposes a series of six grades have been used. Grade 1 represents a fine birth coat in which the locks are arranged in small spiral tufts. The succeeding three grades are based on an increasing abundance of halo hairs, which appear as a long outer coat above the fine and short inner coat. In grade 5 the halo hairs are so dense that there is no obvious distinction between outer and inner coats. Grade 6 is an extreme development in which it is also impossible to

distinguish outer and inner coats and in which the fibres are grouped in large spiral tufts.

The study of the morphology of the fibre types and their incidence in the various grades is not yet complete; but it seems certain that the principal types of fibres described by Dry[1] are also found in the Australian merino.

The work of Dry and Fraser (cited by Fraser[3]) suggested that the coarse birth-coat grades of the New Zealand Romney Marsh breed were the result of a single dominant gene. This observation led us to dichotomize the data between grades 4 and 5, and to examine the results on a 'fine' *v.* 'coarse' classification. It was postulated that the 'coarse' grades were the result of a single dominant gene and that all parents graded 'coarse' were heterozygous. Examination of pedigrees and breeding performance indicated that this latter postulate was quite reasonable. There is evidence that, as mature animals, there has been some selection against the 'coarse' grades; this selection may have been more severe against homozygous dominants. Denoting coarse grades by *Aa* (heterozygotes) and fine grades by *aa*, the accompanying table shows the results of the three possible matings.

Mating	Progeny grading	
	Coarse (*AA* + *Aa*)	Fine (*aa*)
Aa × *Aa*	17	7
Aa × *aa*	69	84
aa × *aa*	6	108

With the exception of matings in line 3, there is good agreement with the single dominant gene hypothesis. The occurrence of 'coarse'-coated progeny from the mating of fine-coated parents at first sight appears to invalidate the postulate. However, such a position could arise either from misgrading of animals or from complications arising from incomplete penetrance and expressivity. As the six individuals and their parents are in grades 1, 2 or 3, misgrading is unlikely to be the cause of the discrepancy. The fact that the six individuals are all progeny of one ram suggests that the latter alternative is more probable, and that this ram, with birth-coat grade 3, had, in fact, a 'coarse' genotype. Fraser[3] records similar discrepancies in the Romney Marsh breed.

Observations to date on the correlation between birth-coat grade and characters of the adult fleece may be summarized as follows. Increasing birth-coat grade is associated with increasing variability of fibre diameter and decreasing number of crimps per inch; but it does not appear to be associated with mean fibre diameter. Under favourable nutritional conditions there is a close association between mean fibre diameter and crimps per inch in the fine birth-coat grades, but a much lower association in the coarse grades. There is a suggestion in our data that this association in the fine grades does not hold so strongly under conditions of poor nutritional environment.

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Cultivation of Canine Hepatitis Virus in Embryonated Hen's Eggs and its Subsequent Transmission to Dogs

Virus hepatitis of dogs was described by Rubarth[1] in 1947 in Sweden, and since then a natural epidemic of the disease has been observed in Britain[2]. From the organs of two dogs dying during this epidemic, the infective agent has been cultivated by the inoculation into the yolk sac of embryonated hen's eggs for twelve successive passages, after which it was passaged back to dogs with reproduction of the disease.

Portions of the liver and lungs from the two original cases or, later, parts of the yolk sac and embryo liver were prepared as inocula by grinding with sand and mixing with broth containing 70 per cent inactivated horse serum and 7·5 per cent glucose to make a 10 per cent w/v suspension, and storing at − 70° C. After the addition of 500 units of penicillin and streptomycin per ml., or filtration through a 'Gradocol' membrane of average pore diameter of 640 mμ, 0·2 ml. of the inoculum was inoculated into the yolk sac of 6th-day embryonated hen's eggs. The first-passage eggs were harvested on the sixth day after inoculation and no abnormalities were detected. In subsequent passages, half the four to six eggs inoculated were harvested on the sixth day thereafter and the remainder on the tenth day. In the second passage, one of four embryos died while three of the four showed hæmorrhages in the liver. With succeeding passages the proportion of deaths increased until, during the fifth passage and after, half the embryos died before the tenth day. These eggs were bacteriologically sterile on culture. From the fifth passage also nearly every embryo inoculated showed hæmorrhage and necrosis of the liver, with ascites in some cases. Macroscopically the liver lesions varied from small pale opaque areas near the lower margin to a condition approaching complete necrosis, which microscopically were confirmed as circumscribed or large areas of necrosis with either karyorrhexis or complete disappearance of the nuclei. In the areas in which hæmorrhages were present, there was evidence of necrosis of the wall of small vessels with damage to the endothelial cells. Inclusion bodies were not found.

Material from the twelfth passage was made up as a 2 per cent suspension in serum broth, filtered through a 'Gradocol' membrane of 750 mμ average pore diameter and passed back to dogs by inoculating 0·05 ml. intraocularly under general anæsthesia into two seven-weeks-old greyhound pups born and reared in isolation. The reaction of these animals to inoculation was followed by clinical observations for twenty-one days and by testing for specific antigen and antibodies by Larin's technique[4].

Pup 1 showed no eye reaction, nor any clinical signs of illness for twenty-one days, but the complement fixation test demonstrated the subsequent development of specific antibodies. Pup 2 developed a marked diffuse dense central opacity of both corneas on the third day after inoculation, which decreased slowly without any vascular reaction until the eighth day. From the third to the sixth day the pup showed increasing malaise, reduced food intake and unformed stools, with a rise of temperature of less than 1° F. The dog was destroyed when clinically convalescent on the eighth day. Macroscopically the internal organs were normal, but microscopically the liver showed vacuolation of cytoplasm and loss of nuclei in the centrilobular liver cell columns; no inclusion

bodies were seen. Serological examination showed no antibodies in the blood, but the presence of specific antigen was detected in the liver, from which the virus was passaged to a third dog.

Liver from pup 2 stored at − 30° C. for three months was made up as a 10 per cent w/v purified suspension in saline[3] and inoculated into an eight-weeks-old mongrel pup No. 3, injecting 0·05 ml. into each eye and 10 ml. intraperitoneally. The pup developed a diffuse light central opacity of both corneas on the seventh day, which disappeared in 48 hr. without any vascular reaction, coinciding with which was a morning hyperthermia of 103·6°–104° F.; the dog thereafter was normal. Serological tests showed the presence of specific antigen in the blood on the ninth day and the appearance of antibodies from the twenty-eighth day onwards.

The clinical signs of systemic illness produced were mild, but quite definite; a similar syndrome, including the corneal lesions, has been observed in natural epidemics[2] and in experimental infections[3] of canine virus hepatitis. This diagnosis of specific virus hepatitis is supported by the detection of antibodies in the survivor of the first passage (pup 1) and of antigen in the liver of pup 2, and the confirmation of the presence of virus in this liver by the second passage inoculation into pup 3, which afterwards showed clinical illness with specific antigen and antibody in the blood.

These results show that from cases of virus hepatitis in dogs an agent can be grown in embryonated hen's eggs after yolk-sac inoculation, and that material from the twelfth egg passage filtered through a 'Gradocol' membrane can cause the clinical disease in dogs with the occurrence of specific antigen in liver and blood and of specific antibodies in the blood.

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Rapid Rate of Turnover of Potassium Ions in Kidney Slices

The steady-state turnover-rate of potassium ions in guinea pig cortex slices *in vitro* was measured by the isotope procedure developed by Krebs, Eggleston and Terner[1]. There is a rapid initial loss of potassium when kidney slices are placed in physiological saline solutions, but if 0·01 *M* α-ketoglutarate is present, the slices reabsorb the lost potassium[1] and maintain the initial concentration during at least the interval from 25 to 35 min. after the start of the incubation. When this steady state had been reached, potassium-42 chloride was added to the medium and the tissue removed either two or four minutes later. Measurements were then made of the radioactivity and the potassium content of tissue and medium with a liquid counter[2] and a flame photometer[3]. Typical results are shown in the accompanying table.

Turnover of Potassium in Kidney Cortex Slices

Guinea pig tissue suspended in 2 ml. bicarbonate saline containing 0·02 *M* glucose and 0·01 *M* α-ketoglutarate. Potassium-42 chloride added after 25 min. preliminary incubation

Incubation time after addition of potassium-42 ions		2 min.
Fresh weight of tissue		240 mgm.
Potassium ions in tissue	before incubation	17·5 μmol.
	after incubation	17·3 μmol.
Potassium ions in medium		12·6 μmol.
Radioactivity of medium	before incubation	5,320 counts/min.
	after incubation	3,680 counts/min.
Potassium ions exchanged		2·8 μmol./min.
Turnover of tissue potassium ions		16 per cent/min.

The turnover-rate (v/b) was determined from the formula[1]:

$$v = \frac{ab}{t(a+b)} \ln \frac{bx_0}{x(a+b) - ax_0},$$

where v is quantity of total potassium passing from tissue to medium, and in the opposite direction, per unit time; a is quantity of total potassium in medium; b is quantity of total potassium in tissue; x_0 is quantity of potassium-42 added to the medium at time $t = 0$; x is quantity of potassium-42 in medium at time t.

The average rate of turnover from eight experiments was 15 per cent/min. This means that an amount equal to the whole potassium content of the cells leaks out, and is absorbed against a concentration gradient, about every seven minutes. This rate of nine times an hour or more than two hundred times a day is the fastest so far found, being nearly twice that in retina[1], four times that in brain[1] and about five hundred times that in red blood cells[4–6].

A full account of this work will be submitted for publication in the *Biochemical Journal*.

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Non-adaptive Characters in Evolution

In a recent communication[1], Dr. A. J. Cain holds that we must now accept that there is no evolution of non-adaptive—or neutral—characters in Nature. He holds this on the ground that certain characters that were previously thought to be neutral have been shown to be correlated in distribution with environmental conditions, and may therefore have some selective value. He thinks that selective value should be assumed in all characters until the contrary is proved.

The subject is controversial; many biologists believe that much differentiation, especially of the minor or trivial differences of micro-evolution, is non-

adaptive[2]. Also the subject is complex, and not one that can be adequately discussed in letters in *Nature*. But it may be worth while stating some general grounds for not agreeing with Cain's conclusion, even if we were to admit the selective value of the recently investigated characters that he mentions.

I think it is true that the present position is as follows. Wright[3] has given a theoretical basis for belief that non-adaptive evolution is possible under certain conditions. Many biologists accept his theoretical views and believe that the required conditions occur commonly in Nature. So long as no objections generally accepted by biologists as valid are raised against Wright's theory, we cannot, I think, disregard it, though our estimates of the relative importance of adaptive and non-adaptive evolution must in the end certainly depend on observation and experiment. Differentiations in natural populations are exceedingly various and of different genetic types, and unfortunately very few have yet been adequately investigated.

To assume on the evidence of these few investigations that all differentiation is adaptive seems to me unjustified. I believe that we should at present adopt a more cautious attitude. We must, I think, accept non-adaptive evolution as theoretically possible and, until it is shown to play no significant part in natural differentiation, we must give it a place in our general view of evolutionary theory. In the future we may be able to reach a sounder estimate of its importance, and the many biologists who now believe that it plays a significant part may then be shown to be wrong. We cannot now assume that they are. This was the attitude that I tried to adopt in writing the account of evolutionary theory[4] to which Cain refers.

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The Interglacial Beds at Hoxne, Suffolk

Recent attempts by Woldstedt[1,2] to correlate the Pleistocene sequence in south-east England with that in northern Germany are based on the two marine horizons in each area: the correlation of the March Gravel in England with the Skaerumhede Series on the Continent is probably correct on faunal grounds, and the correlation of the Corton Beds of East Anglia with the deposits of the Holstein Sea in Germany is possibly right, though more confirmation is needed from the fossils. Woldstedt's chief difficulty was to fit the three glacial stages of Germany to the four glacial stages found in East Anglia, and this problem turns on the recognition of an equivalent of the Hoxne Interglacial of Suffolk in Germany. It is therefore important to summarize what is known so far of the interglacial beds at Hoxne.

The general geology of the surroundings of Hoxne is well known, consisting of a till or boulder clay made mostly of Bunter and Jurassic material with some chalk and flint, resting on chalky sand and gravel with occasional marine shells and plates of barnacles. This series forms a plateau at about 130–150 ft. above sea-level, and is eroded by the present stream valleys. The freshwater beds at Hoxne have been formed in a hollow in this plateau boulder clay, and all past investigators agree that they are earlier than the erosion of the modern valleys[3–7]. Enlargement of the brickworks in recent decades has exposed sand and stony brickearth overlying the freshwater series, which have been considered as formed under glacial or peri-glacial conditions[6–8].

The freshwater series represents a climatic succession which has been worked out in great detail, and plant remains collected by Clement Reid[5] show that the oldest clay (Bed *E*), resting on the bottom till, was formed in still water in a temperate climate; after this, a lignite Bed *D* was formed, representing an alder thicket; lacustrine conditions were next responsible for a black loam (Bed *C*), with some arctic plants; a cold climate continued, with the formation of peat and thin gravel layers (Bed *B*); and finally, temperate conditions returned during the deposition of the top blue silt (Bed *A*). The whole of these lacustrine and marsh beds were finally covered by the stony loams representing arctic conditions. The freshwater shells from the lacustrine series confirm the evidence of the plant remains, and the pollen analyses from Beds *B* and *A* point to surrounding birch and pine forest during stage *B* giving place to oak–alder forest with elm and lime at the beginning of Stage *A*[7]. Few large mammals have as yet been traced to definite horizons, but mammoth and ? reindeer have been recorded from Bed *B*, and horse, red deer and beaver from Bed *A*. On the evidence we have at present, it is not advisable to consider the cold episode *C* as a separate 'glaciation'.

Unfortunately, these mammals cannot yet be used for long-distance correlations; but the matrix and erratics in the till at the base of the series are identical with those in the Lower Chalky (Lowestoft) Till of this region, and a completely new assemblage of erratics appears in the top glacial or peri-glacial stony bed, which agrees with that in the Upper Chalky (Gipping) deposits in the areas south and west of Hoxne. So far as our present evidence goes, therefore, the bottom glacial deposit at Hoxne is the upper glacial deposit of the sequence farther east in Suffolk[8], and the top glacial bed at Hoxne is contemporaneous with the lower glacial bed at Brundon[9] and in the Fen District[10]. The main erratics from this top bed used for correlation include a lump of orthoclase felspar, olivine-basalts, schistose grits and augen gneiss. These rock-types are unknown in Suffolk earlier than the Gipping glacial horizon. This geological evidence can be summed up by saying that the Hoxne freshwater beds were formed during an important interglacial stage, and that this stage is the second of the three interglacials so far recognized in Suffolk.

This geological dating agrees well with the archæology. Implements have only been found in place in Beds *A* and *B*, and include High Lodge or Clactonian III flakes[7] and Acheulean bouchers or hand-axes. The bouchers were called "Late Acheulean" by Moir; but a recent examination of about thirty specimens, including ten found recently, has shown that none of them is as late as the Final Acheulean of the French classification, and in my opinion should be identified with the "Late Middle" Acheulean at the end of the Swanscombe series in Rickson's pit[11]. This conclusion is based on a combination of characters including the proportion of ovates (30–40 per cent of those examined), thickness in relation to width, number

and depth of flake scars, amount of controlled flaking and secondary work and the extent to which tranchet blows were used. Also an unusually high percentage (44 per cent) have twisted edges. Finally, Lav-alloisian specimens make their first appearance in the Hoxne sequence in the top glacial bed, which helps to confirm the conclusion that the Hoxne inter-glacial is contemporaneous with Swanscombe but earlier than Brundon.

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Light Filters of Coloured 'Perspex'

Light filters of coloured glass and gelatin are in common use for visual and photoelectric photometers. They are satisfactory, on the whole; but the glass filters are easily broken, and those of gelatin require to be mounted between glass to protect them from water. The transparent polymethyl methacrylate 'Perspex' is now obtainable in several colours and in sheets. This material is very tough and difficult to break, but is easily worked, and can be cut with a saw. The spectral characteristics of the different kinds of coloured 'Perspex' are not such as to make them directly usable as light filters in photoelectric photometers, because of considerable transmission in the red and infra-red by those which are violet, blue and green (Fig. 1); but by combining sheets of the coloured 'Perspex' with the Ilford copper red-absorbing gelatin filter 803, a set of nine serviceable light filters, covering the visible spectrum, has been prepared (Fig. 2), and these have been found to be sturdy and almost unbreakable, and well suited to laboratory use.

The gelatin filter is placed between two sheets of 'Perspex', either coloured + colourless or of different colours, and the edges bound with 'Perspex' cement, 'Cellophane' tape or gummed paper. The combina-

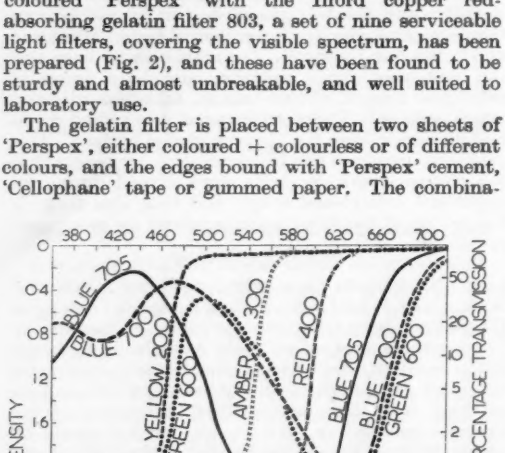

Fig. 1. Spectral transmissions of coloured 'Perspex', ⅛-in. sheets.

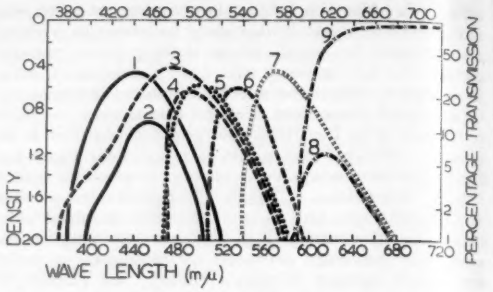

Fig. 2. Spectral characteristics of light filters made from coloured 'Perspex' and Ilford gelatine filter. (See table)

tions which have been found most useful for photo-electric colorimeters are given in the accompanying table. The 'Perspex' used was cut from coloured ⅛-in. sheet material; and the red-absorbing filter was Ilford sheet gelatin No. 803. Messrs. Allan Industries, Farnham Common, Bucks, prepared the filters for use.

Light Filters of Coloured 'Perspex' and Ilford 803

Final colour	Max. transmission (mμ)	Coloured 'Perspex' No.	Ilford gelatin
1. Violet	440	Blue, 705	803
2. Blue-violet	455	Blue, 705 + blue, 700	803
3. Blue	470	Blue, 700	803
4. Blue-green	490	Blue, 700 + yellow, 200	803
5. Green	500	Green, 600	803
6. Yellow-green	530	Yellow, 200	803 + 110
7. Yellow	570	Amber, 300	803
8. Orange	615	Red, 400	803
9. Red	>630	Red, 400	—

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Solution of Polynomial Equations with the Aid of the Electrolytic Tank

A. Bloch[1] recently extended to complex coefficients Lucas's method[2] of the solution of polynomial equations with the aid of an electrolytic tank. Points of the tank represent complex numbers either directly or after a conformal transformation. In the extended method, sinusoidal currents, in complex vector notation proportional to the residues of a certain rational function with simple poles, are impressed at points corresponding to these poles. Then the points at which the electric field is circularly polarized correspond to the roots of the polynomial equation. The root-points can be found by exploring the tank systematically.

Bloch gave no indication of how his extension could be practically realized. Relevant practical tank measurements[3,4] had been carried out with all electrode currents in phase and one electrode earthed. Consequently the twin-probe assembly which, up to this time, had been used to measure electric field gradients had to be connected to a differential amplifier.

We found that a very satisfactory system of establishing adjustable complex electrode currents can be based on the use of a transformer with a floating and tapped secondary winding. Sets of small numbers of parallel admittances, say six, that are in the ratios $1 : 10 : 100 : (1 + j) : (10 + 10j) : (100 + 100j)$, are connected to a limited number of tappings, say, at 0, ± 20, ± 40, ± 60, ± 80 and ± 100 volts. Then any current can be adjusted with an accuracy of 1 in 1,110, any point of the electrolyte can be earthed and an ordinary amplifier and a vibration galvanometer used as detector. A Wagner auxiliary earth eliminates the entry of undesired additional currents at the earthed point. For picking up the gradients in two perpendicular directions a quadruple probe assembly can be used, and it is possible to employ a passive network composed of resistors and condensers that has zero output when the field applied to the quadruple probe assembly is circularly polarized. A passive differential network consisting of a parallel twin-T of resistors and condensers can be designed in such a way that the effects of a maladjustment of the Wagner earth are minimized, so that the Wagner earth requires only occasional adjustment while the tank is explored. Further, it was found that the effect of rotating the quadruple probe assembly when exploring the tank, and injecting in series with the vibration galvanometer a suitable small external voltage, was to make the influence of stray voltages induced in the leads and the amplifier innocuous.

The accuracy of the procedure described can be predicted by mathematical formulæ into which values for the estimated inaccuracy in the setting of the electrode currents and in the positions of the electrodes, as well as the value for the sensitivity of the detector, are substituted. An iterative procedure can be developed which permits the accuracy in determining the roots of polynomial equations to be increased at will.

The quadruple probe assembly can be employed also at a fixed point of the tank, and the current from, or the position of, an additional electrode can be considered the variable by the adjustment of which the field at the probe assembly becomes circularly polarized. This technique makes possible the quick computation of the values of a rational function with given poles for any complex argument. If the rational function has poles of higher order, these can be simulated by simple poles arranged symmetrically around the point in question. The currents to be impressed at these simple poles follow from the coefficients of Laurent's expansion representing an individual higher-order pole by formulæ which are similar to those used in the symmetrical components treatment of polyphase systems.

Theoretical and experimental work has been carried out at the Electrical Engineering Department of the University of Sydney and will be described in the *Australian Journal of Scientific Research*.

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May 7.

[1] Bloch, A., VIIth International Congress of Applied Mechanics, **4**, Paper No. 28, 324 (London, 1948).
[2] Lucas, F., *C.R. Acad. Sci., Paris*, **106**, 645 and 1072 (1888).
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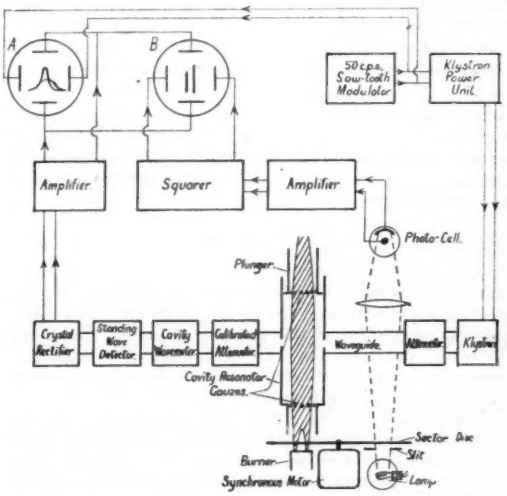
A Cavity Resonator Method for Electron Concentration in Flames

In the course of investigations on the electron concentration produced by evaporation of electrons from the carbon particles in the luminous flames of acetylene and air, it was found that the method of microwave attenuation described by Belcher and Sugden[1] was not sufficiently sensitive. A more sensitive method of obtaining this concentration is to determine the conductivity of the flame by measuring the change in characteristics of a cavity resonator when the flame is inserted in it.

The apparatus (see diagram) consists of a cylindrical water-cooled copper and brass cavity resonator, tuned by a plunger to oscillate in the (TE,0,1,1) mode at about 9,800 megacycles per second. A cylindrical flame passes axially through platinum gauzes, at the base of the cavity and in the tuning plunger. These gauzes consist of radial and circular wires spaced so as to reflect most of the radiation falling on them, without noticeably impeding the flame. Energy from a 723 A/B klystron oscillator, frequency-modulated by a 50 c./s. saw-tooth wave, is fed into the cavity through an iris, and the transmitted energy passes through another iris into the receiving waveguide system, which includes a calibrated attenuator, a cavity wavemeter and crystal detector.



The output of the crystal is applied to the Y plates of two oscilloscopes A and B. The X plates of oscilloscope A are connected to the saw-tooth modulator so that it shows the frequency/amplitude characteristics of the resonator. The most convenient way of taking measurements has been achieved by chopping the flame at 12·5 c./s. with a rotating sector disk, which also interrupts light falling on a photocell, the output of which is amplified and applied to the X plates of oscilloscope B, giving two vertical signals relatively displaced, with amplitudes corresponding to the maximum power transmitted with and without flame; these amplitudes can be compared using the calibrated attenuator. This chopping also serves the useful purpose of preventing distortion and melting of the gauzes by the flame.

In this apparatus the change of resonant frequency of the cavity by the dielectric effect of the flame is

small compared with resonance damping due to conduction in the flame, given by the following formula[2]:

$$\sigma = \frac{0{\cdot}00169\ R(t^{1/2} - 1)}{r^2 Q},$$

where σ(mho-cm.) is the conductivity of the flame of radius r cm. in a cavity of radius R cm., and with a Q factor of Q in the absence of flame; t is the ratio of the power transmitted by the cavity in the absence of flame to that in its presence. On the basis of the theory developed by Margenau[3,4], it can be shown that σ is proportional to the electron concentration, the factor of proportionality being sensibly constant under the present conditions and having a value of $1{\cdot}3 \times 10^{20}$. Whereas the direct attenuation method of Belcher and Sugden was only capable of measuring electron concentration to about 5×10^9 per c.c., the present method is capable of extending this down to about 10^8 electrons per c.c., that is, a pressure of 2×10^{-9} atmosphere at flame temperatures in the region of 2,000° K.

The flames studied contained about 20–30 per cent of acetylene and gave temperatures ranging from 2,240° to 2,180° K., both by Kurlbaum's method[4] and the sodium line reversal method[5], the cooler and more luminous flames being the acetylene-rich ones. According to a theorem of statistical thermodynamics[6] the number of electrons per c.c. in equilibrium with a solid is given by:

$$n = \frac{2(2\pi m_e\ kT)^{3/2}}{h^3} \cdot \exp(-\chi/kT),$$

where m_e is the electron mass and χ the thermal work-function of the metal. If the solid is not infinite in extent, however, and consists of N spherical particles per c.c. of mean radius $\bar{r}$, the exponential term will be modified to:

$$-[\chi + f(r)]/kT,$$

where $f(r) = (300\ ne)/(N\bar{r})$ electron volts. Preliminary observations by electron microscopy of the particles have shown $\bar{r}$ to be about 200 A., and theoretical calculation of the amount of carbon indicated 10^{11}–10^{12} particles per c.c., which should make $f(r)$ negligible compared with χ, which is 4·34 electron volts according to Reimann[7].

The results obtained with this apparatus show an electron concentration very near the theoretical value for flames very rich in acetylene, but falling off as the flame becomes hotter and richer in air to values of about one-quarter of theoretical. This is a greater divergence than corresponds with the estimated $f(r)$; but the methods of measurement of N and $\bar{r}$ require further development, and may allow of an explanation of this. The detailed results will be described elsewhere.

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May 22.

[1] Belcher and Sugden, *Proc. Roy. Soc.*, A, 201, 480 (1950).
[2] Adler, *J. App. Phys.*, **20**, 1125 (1949).
[3] Margenau, *Phys. Rev.*, **69**, 508 (1945).
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[5] Lewis and von Elbe, "Combustion, Flames and Explosions of Gases", chapter 19 (Camb. Univ. Press, 1938).
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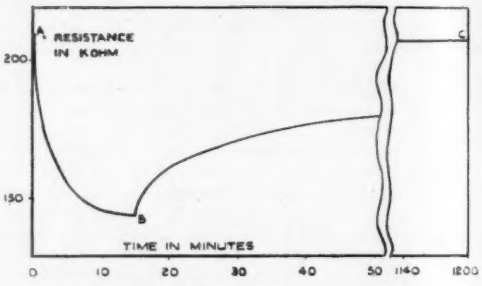
[7] Reimann, *Proc. Phys. Soc.*, **50**, 496 (1938).

A Photo-conductive Effect in Tellurium Film

In the course of measurements of the electrical resistance of thin films of tellurium on glass plates, it became clear that the resistivity of a film decreased on exposure to sunlight.

A tellurium film was placed in a dark box for a few days in order to make sure that it was settled in the dark state. Leads through the sides of the box permitted the measurement of the resistance of the film. The lid of the box was then removed so that direct sunlight could fall on the film. It was found that the resistance decreased rapidly at first and then slowly until a steady state was reached after about 15–60 min. exposure to light. The steady-state resistance value depended upon the light intensity but was about two-thirds of the resistance in the dark. On closing the box it was found that the film recovered its resistance value after about a day in darkness.

Measurements were made on a number of films prepared at different times, and in each case the effect was much the same. A typical resistance–time curve is shown in the accompanying graph. It was observed that the speeds of response of the various specimens were quite different even for samples which had been adjacent in the evaporating chamber.



AB, exposed to sunlight; *BC*, recovery in darkness

The speeds of response and recovery were compared by measuring the time taken for the resistance to reach the geometric mean of the initial and steady values. The recovery measurements were the more reliable as it was easier to maintain steady conditions in the dark box than when facing the summer sky. The response times as defined above varied between 2 and 14 min., and the recovery times between 20 and 100 min. There was no simple correlation between the response and recovery times. It will be noticed that the time-scale for this effect is very much greater than for those utilized in the normal photocells, which have response times of a small fraction of a second. It is thought that this effect might be used in photocells required to be insensitive to rapid fluctuations in illumination.

The tellurium films were formed on 3-in. by ½-in. glass slides. Platinum end contacts were deposited on the glass from a solution and fired at 700° C. The tellurium was deposited upon the slide by vacuum evaporation. The film thickness was of the order of 3×10^{-6} cm.

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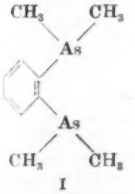
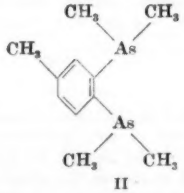
Stereochemistry of Gold

In its complex compounds, tervalent gold appears to be invariably four-covalent, the four bonds being co-planar and pointing to the corners of a square, as in $K[AuBr_4],2H_2O$ [1]. This suggests the use of $5d6s6p^2$ bonds, which is in accordance with the observed diamagnetism of tervalent gold compounds[2]. The stereochemistry of univalent gold, however, is less well defined. As a rule, the co-ordination number is two, and examples of this include the anion[3] $[AuCl_2]^-$ and the phosphine complexes of the type $[R_3P,AuX]$, where X = halogen[4]. In those cases which have been investigated by X-rays, the two bonds to the gold atom are co-linear[5].

In contrast to the behaviour of univalent copper and silver, univalent gold shows a co-ordination number of four only very rarely. Meyer[6] reported a compound of the formula $(NH_3)_3AuCl$, while Levi-Malvano[7] has described the triethylphosphine complex ammine $(NH_3)_2(Et_3P)AuCl$. Complex thiosulphates of the type $M^I_3[Au(S_2O_3)_2]$ are well known[8], but it is uncertain whether the thiosulphate group behaves as a chelate group or is attached through one sulphur atom only; in the latter case the gold atom would be two-covalent. The compound $K[Au(CN)_2,dipyridyl]$ has been studied by X-rays[9], and it was reported that the gold atom is square co-ordinated; this result is unexpected, for one might anticipate that four-covalent aurous complexes would be tetrahedrally co-ordinated, as is the case for the four-covalent complexes of univalent copper and silver[5]. The subject of the preparation and structure of the four-covalent complexes of univalent gold clearly offers a considerable field for investigation.



I



II

It seemed that the preparation of these complexes should be favoured by the use of suitable strong chelate groups, since the attachment of one molecule of the chelate compound, owing to its shape, prevents the use of linear sp bonds and hence might be expected to favour the addition of a second chelate molecule, resulting in the formation of four sp^3 tetrahedral bonds. Using the ditertiary arsine chelate group, *o*-phenylene*bis*(dimethylarsine) (I), a series of complexes of univalent gold, similar to those of univalent copper[10], has been prepared. By treating an alcoholic solution of chlorauric acid with the ditertiary arsine in the presence of a small amount of hypophosphorous acid and adding a little of the corresponding halide, compounds of the general formula $[Au(diarsine)_2]X$, where X = a halogen, have been prepared. They are exemplified by the bromide, $[Au(diarsine)_2]Br$, which is obtained as yellow crystals, melting point 226° C. (found, C, 28·0; H, 4·2 per cent; $C_{20}H_{32}As_4BrAu$ requires: C, 28·3; H, 3·8 per cent). These compounds react with perchloric acid in alcoholic solution to yield the compound $[Au(diarsine)_2]ClO_4$ as a white insoluble powder (found: C, 27·96; H, 3·8 per cent; $C_{20}H_{32}As_4O_4ClAu$ requires: C, 27·7; H, 3·7 per cent). This substance decomposes with explosive violence when heated above 300° C. Its salt-like character is demonstrated by the conductivity of its solution in nitrobenzene (molecular conductivity = 28·2 mho at a concentration of $3·05 \times 10^{-3}$ molar); the molecular conductivity of uni-univalent electrolytes in nitrobenzene[11] at the above concentration is usually about 20–30 mho. The formation of this perchlorate provides good evidence for the existence of the $[Au(diarsine)_2]^+$ cation. These aurous compounds are diamagnetic, suggesting the use of $6s6p^3$ tetrahedral bonds. Their physical and chemical properties are being investigated further. Since the ditertiary arsine is strongly attached to the aurous atom, it is proposed to prepare the corresponding gold complexes of the unsymmetrical chelate group (II); if the four bonds to the gold atom are arranged tetrahedrally, it may be possible to effect a resolution into optically active forms, thereby establishing the stereochemistry.

Oxidation of these compounds yields complexes of the type $[Au(diarsine)_2]I_3$, obtained as dark red crystals, melting point 246° C. (found: C, 21·1; H, 3·1; I, 32·6; Au, 16·9 per cent. $C_{20}H_{32}As_4I_3Au$ requires: C, 20·9; H, 2·8; I, 33·1; Au, 17·15 per cent). Although this compound could be a perhalide, involving the I_3^- ion, its properties indicate that the gold atom is tervalent. If this be so, then the cation $[Au(diarsine)_2]^{+++}$ will be square like the corresponding red diamagnetic nickel ion[12] $[Ni(diarsine)_2]^{++}$.

A more detailed discussion of the preparation and properties of these compounds will be published elsewhere in due course.

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June 5.

[1] Cox and Webster, *J. Chem. Soc.*, 1635 (1936). See also Sidgwick, "The Chemical Elements and Their Compounds", 183 *et seq.* (Oxford, 1950).
[2] Selwood, "Magnetochemistry", 103, 182 (Interscience, 1943).
[3] Wells, H. L., *Amer. J. Sci.*, **3**, 315, 417 (1922).
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Dipole Moments of Aliphatic and Aromatic Amines

An investigation of the influence of the solvent on the dipole moments of aliphatic and aromatic amines was commenced some years ago[1]; but many of the results have not yet been published. A recent paper[2] has duplicated some of the work of this research. The accompanying table includes a selection of the measurements of the dipole moments of amines, some of which have not previously been determined. In the case of *n*-propyl and *n*-butyl-amines, the substituted anilines, with the exception of *n*-propyl and ethyl-*n*-propylanilines, and diphenyl-amine, which were investigated in benzene at 25° by Le Fèvre *et al.*[2], the agreement between the two sets of results is very good. No values of the dipole

moments of di-*n*-propyl, tri-*n*-propyl, di-*n*-butylamines, *n*-propyl and ethyl-*n*-propylanilines, and of the other compounds in solvents other than benzene, are available. In the aromatic series, aniline has been studied in solution[1,3] and aniline and dimethylaniline in the vapour state[4].

The polarization at infinite dilution ($P_{2\infty}$), the electronic polarization (P_E) and the dipole moment (μ) in Debye units refer to solutions of the highly purified specimens of the amines in the solvents stated at 20·0° C. No correction is applied for the atomic polarization, and P_E is taken as the molecular refraction for D light of the pure compound.

Amine	Solvent	$P_{2\infty}$ c.c.	P_E c.c.	μ
n-Propylamine	hexane	59·0	19·4	1·38
	benzene	57·3	19·4	1·35
Di-*n*-propylamine	hexane	55·5	33·5	1·03
	benzene	57·1	33·5	1·07
Tri-*n*-propylamine	benzene	59·5	47·7	0·75
n-Butylamine	hexane	62·0	24·1	1·35
	*cyclo*hexane	61·8	24·1	1·35
	benzene	64·5	24·1	1·39
Di-*n*-butylamine	hexane	65·8	42·8	1·05
	benzene	67·3	42·8	1·09
Methylaniline	hexane	96·6	35·7	1·71
	benzene	93·4	35·7	1·67
Dimethylaniline	hexane	92·7	40·7	1·58
	benzene	93·5	40·7	1·59
Ethylaniline (see ref. 5)	hexane	100·2	40·4	1·70
Diethylaniline	hexane	120·8	50·2	1·84
	benzene	120·0	50·2	1·83
n-Propylaniline	hexane	104·8	45·1	1·69
	benzene	104·1	45·1	1·68
Ethyl-*n*-propylaniline	hexane	124·1	54·9	1·82
	benzene	125·2	54·9	1·84
Diphenylamine	hexane	79·7	58·2*	1·02
	benzene	79·9	58·2	1·02

* Obtained from measurements on solutions.

Measurements of the dipole moments of *n*-propyl and *n*-butylamines in the vapour state and in solution in benzene[2] have shown that both these compounds exhibit a positive solvent effect, that is, an increase of dipole moment in solution as compared with the value for the vapour. The present results in benzene confirm, and those in hexane extend, this conclusion.

The increase of dipole moment from ethyl to diethylaniline, which may be compared with the increase from *n*-propyl to ethyl-*n*-propylaniline, is found in both hexane and benzene.

In most of the examples in the table, the dipole moment changes only slightly with the solvent, while in others no differences between the moments are found.

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June 13.

[1] Cowley and Partington, *J. Chem. Soc.*, 1598 (1938).
[2] Barclay, Le Fèvre and Smythe, *Trans. Farad. Soc.*, **47**, 357 (1951).
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[4] Groves and Sugden, *J. Chem. Soc.*, 1782 (1937).
[5] μ = 1·68 D. in benzene at 20°: Cowley and Partington, *J. Chem. Soc.*, 1255 (1933).

Formula for Creep Curves of Metals

Many formulæ have been presented for the time-strain curves of metallic creep, among which Andrade's formula[1],

$$l = l_0 (1 + \beta t^{1/3}) \exp (kt),$$

seems to have attracted much attention; but it has not been possible to find a satisfactory explanation of it. Hence we thought it worth while to look for another equation which agrees well with experimental results.

Table 1. Polycrystalline Commercial Aluminium at 320° C. under the Stress of $1·78 \times 10^6$ dynes per square cm.

Time (sec.)	Length observed (mm.)	Length calculated from our formula (mm.)	Length calculated from Andrade's formula (mm.)
7	50·857	50·872	50·465
25	51·429	51·325	51·280
118	53·137	53·130	53·278
439	57·345	57·355	57·468
1,110	64·973	65·010	64·782

Table 2. Single Crystal of Commercial Aluminium at 350° C. under the Resolved Shear Stress of $3·5 \times 10^7$ dynes per square cm.

Time (sec.)	Shear strain observed	Shear strain calculated from our formula	Length observed (mm.)	Length calculated from Andrade's formula (mm.)
95	0·0225	0·0223	50·515	50·438
313	0·0511	0·0471	51·142	51·176
990	0·1122	0·1118	52·568	52·568
3,156	0·2475	0·2521	55·847	55·593
8,040	0·4548	0·4516	61·133	61·515
12,205	0·5886	0·5866	64·728	66·537
19,260	0·7869	0·7946	70·241	75·525

We have carried out extensive experiments on the creep of polycrystals and single crystals of high purity and commercial grade aluminium at elevated temperatures under constant stresses. The constant stress device used was the same as that of Andrade[2] in the case of polycrystalline materials, and was somewhat modified in the case of single crystals to keep the stress constant in the slip direction in the slip plane. After examining all the experimental results, we got the following time-strain equation:

$$s = a - \frac{1}{bt + c} + kt,$$

where s is the resolved shear strain at the time t in the case of single crystals, or the logarithm of the ratio of the length of specimen at the time t to its initial length in the case of polycrystalline materials; a, b, c and k are constants independent of time. If we consider only the transient component, it is readily shown that

$$\frac{ds}{dt} = b(a - s)^2,$$

which is similar to the equation of a second-order chemical reaction. Our equation agrees with the experimental results just as well as Andrade's does in the case of polycrystalline specimens, as shown in Table 1; and it proved to be far better than Andrade's for large strains of single crystals, especially after long times, as is seen from Table 2. Results sufficient to illustrate these points only are included in the tables; full details will be published later.

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University of Tokyo.
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[1] Andrade, E. N. da C., *Proc. Roy. Soc.*, A, **84**, 1 (1910); A, **90**, 329 (1914).
[2] Andrade, E. N. da C., and Chalmers, B., *Proc. Roy. Soc.*, A, **138**, 348 (1932).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 22

SOCIETY OF DAIRY TECHNOLOGY (in the Lecture Room, New Hall, Royal Horticultural Hall, Greycoat Street, London, S.W.1), at 10.30 a.m.—Annual General Meeting.

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Dr. Joseph Needham, F.R.S.: "A Re-valuation of Chinese Astronomy".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Place of Electricity in a National Fuel Policy" (to be opened by the President).

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Prof. A. R. Todd, F.R.S.: "Vitamin B_{12}". (Members of the London Section are invited.)

TEXTILE INSTITUTE, LONDON SECTION (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Mr. K. W. L. Kenchington: "Science of Clothing in relationship to Comfort and Human Efficiency in Cold Conditions".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. Frank Debenham: "The Kalahari To-day".

Tuesday, October 23

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Inborn Differences between Human Beings".*

SOCIETY FOR APPLIED BACTERIOLOGY (at the Medical Society of London, Chandos Street, Cavendish Square, London, W.1), at 4 p.m.—Symposium on "The Effect of Cold on Micro-organisms".

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. Charles Singer: "Technology and History". (Hobhouse Memorial Lecture.)*

INSTITUTION OF CIVIL ENGINEERS, PUBLIC HEALTH ENGINEERING DIVISION (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. R. H. MacDonald: "Relation between Daily Rainfall and Flow of the River Shin". (Members of the Royal Meteorological Society are invited.)

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Mrs. Elise J. Baumgartel: "Archæology and Earliest Egyptian Religion".

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Sir Alan Rowlands: "The Changing Incidence of Disease" (Presidential Address).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. M. Rowell: "Some Sulphur Recovery Processes in Refinery Operations".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. E. H. Thompson: "Some Aspects of the Development of Photogrammetric Plotting Machinery".*

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. W. T. Astbury, F.R.S.: "The Scientific Basis of Medicine, 5, Studies by X-Ray Analysis, Electron Microscopy and Supporting Techniques of the Structure of Biological Macromolecules and the Tissues Formed from Them".* (Further Lectures on October 25 and 30, November 2, 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

ROYAL SOCIETY OF MEDICINE, PSYCHIATRY SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Dr. Jules H. Masserman (Chicago): "Biodynamics and Psychiatry".

Wednesday, October 24

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. Arnold Sorsby: "Prospects in the Control of Genetic Disease".*

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Dr. R. P. Cook: "The Physiology and Psychology of Alcohol".

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. H. O. Smerd: "Recent Developments in Electrically Welded Chains".

Thursday, October 25

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. A. J. Arkell: "The Beginning of Civilization in Egypt".*

PHYSICAL SOCIETY (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. Frank Twyman, F.R.S.: "Sir Charles Parsons and Optical Engineering" (1951 Parsons Memorial Lecture).

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. B. C. J. G. Knight: "The Scientific Basis of Medicine, 6, Aspects of Bacteriostasis".* (Further Lectures on October 30, November 2, 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

BRITISH ORNITHOLOGISTS' UNION (at the Zoological Society of London, Regent's Park, London, N.W.8), at 6 p.m.—Dr. Gustav Kramer: "Orientation Mechanisms of Migrating and Homing Birds".

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Herr Hans Locher: "Electronic Sliver and Yarn Regularity Testers".

Friday, October 26

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM SECTION (in the Caemistry Building, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. A. C. Chibnall, F.R.S.: "Recent Advances in the Chemistry of Insulin" (Bedson Club Lecture). (All Fellows are invited.)

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the APPLIED MECHANICS GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. W. C. F. Hessenberg and Mr. R. B. Sims: "The Principles of Continuous Gauge Control in Sheet and Strip Rolling".

MANCHESTER STATISTICAL SOCIETY, STATISTICAL METHODS STUDY GROUP (at the Albert Hall, Peter Street, Manchester), at 5.30 p.m.—Mr. D. C. Shaw: "Prices and Margins in the Cotton Industry".

GEOGRAPHICAL ASSOCIATION, MANCHESTER BRANCH (in the Geography Room, Central High School for Boys, Whitworth Street, Manchester), at 6 p.m.—Mr. H. B. Rodgers: "The Oil Industry in the Middle East".

Friday, October 26—Saturday, October 27

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 2.30 p.m. and 10 a.m.—Symposium on "The Evaluation of Chemotherapeutic Substances".

Saturday, October 27

BRITISH PSYCHOLOGICAL SOCIETY, SCOTTISH BRANCH (in the Psychology Department, The University, Edinburgh), at 2.30 p.m.—Symposium on "The Psychology of Art".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade A) TO TEACH MATHEMATICS AND PHYSICS, and an ASSISTANT (Grade B) TO TEACH CHEMISTRY, IN THE DEPARTMENT OF SCIENCE, County Technical College, Wednesbury—The Director of Education and Clerk to the Governors, Dept. F.E., County Education Offices, Stafford (October 27).

ASSISTANT CHEMIST IN THE FUELS AND LUBRICANTS SECTION of the Central Laboratory, Chiswick—The Staff Officer, (F./EV.191), London Transport Executive, 55 Broadway, London, S.W.1 (October 27).

ASSISTANT DIRECTOR (with a good honours degree and research experience, preferably in engineering) IN THE CENTRAL RESEARCH ESTABLISHMENT, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/380 (October 27).

ASSISTANT EXPERIMENTAL OFFICERS (with a degree in engineering or physics, or equivalent) IN THE HORTICULTURAL DEPARTMENT—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (October 27).

ASSISTANT LECTURERS (with a degree in mining or engineering, or equivalent)—The Principal, Technical College, Longport, Canterbury (October 27).

LECTURER (with a degree in engineering and good industrial and teaching experience in structural work) IN THE DEPARTMENT OF ENGINEERING, County Technical College, Wednesbury—The Director of Education and Clerk to the Governors, Dept. F.E., County Education Offices, Stafford (October 27).

LECTURER (with a special honours degree in chemistry; industrial or research experience desirable) IN THE SCIENCE DEPARTMENT—The Principal, County Technical College, Stoke Park, Guildford, Surrey (October 27).

LECTURER IN PHYSICS (university degree in physics essential) to teach the subject, including Nuclear Physics and Electrons, to Final B.Sc. and Higher National Certificate standard, and an ASSISTANT, Grade B (university degree essential) TO TEACH PHYSICS up to Intermediate B.Sc. standard and some Mathematics, at the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, 77–79 George Street, Oxford (October 27).

PRINCIPAL (honours graduate with experience of technical education and industry) OF THE WALLASEY TECHNICAL INSTITUTE—The Director of Education, Town Hall, Wallasey (October 27).

SENIOR CLINICAL PSYCHOLOGIST (with an honours degree in psychology, or equivalent qualification, and experience in clinical psychology)—The Physician-Superintendent, St. John's Hospital, Stone, Aylesbury, Bucks (October 27).

TEACHER IN THE DEPARTMENT OF CHEMISTRY AND BIOLOGY (with a good degree in either biology or chemistry, and qualified to teach the other subject up to Inter.B.Sc. standard at least), Leeds College of Technology—The Chief Education Officer, Education Department, Leeds 1 (October 27).

TECHNICAL ASSISTANT IN THE DEPARTMENT OF AGRICULTURE (Fisheries Branch)—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (October 30).

ENGINEERING INSPECTOR (Civil Engineering) in the Ministry of Commerce—The Director of Establishments, Ministry of Finance, Stormont, Belfast (October 30).

BIOCHEMIST to undertake research and laboratory investigation in connexion with urological disease—The Secretary, Institute of Urology, Henrietta Street, London, W.C.2 (October 31).

HONOURS GRADUATE IN PHYSICS, mainly for research and development work in the clinical uses of radioactive isotopes—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middx. (October 31).

LECTURER IN APPLIED MATHEMATICS—The Secretary to Council, Westfield College, Hampstead, London, N.W.3 (October 31).

LECTURER IN LAND SURVEYING at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

SENIOR LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING, University of Natal—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

SENIOR LECTURER or LECTURER IN ANATOMY at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 31).

LECTURER (with an engineering degree or equivalent qualification, and experience in the engineering and/or process industries) IN WORK STUDY (method, motion and time study) in the Department of Engineering Production—The Secretary, The University, Edmund Street, Birmingham 3 (November 1).

ASSISTANT LECTURER or LECTURER IN ENGINEERING—The Registrar, University College, Cathays Park, Cardiff (November 3).

SCIENTIFIC TECHNOLOGIST in the Coal Survey Laboratory at Cardiff—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/379 (November 3).

LECTURER IN ENGINEERING—The Secretary, The University, Aberdeen (November 7).

BIOPHYSICIST (Principal Scientific Officer grade) with first- or second-class honours degree, research experience in general physics and some experience in the application of physics to physiological problems, at the R.A.F. Institute of Aviation Medicine, South Farnborough—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4077/51 (November 8).

PRINCIPAL SCIENTIFIC OFFICER (Sociologist) (with a first- or second-class honours degree or high qualifications in one of the social sciences, and considerable experience in the use of social survey methods or operational research technique) in the User Requirements Division of the Building Research Station of the Department of Scientific and Industrial Research—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4084/51 (November 8).

ELECTRICAL ENGINEERS in the Admiralty—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.210/51 (November 15).

SENIOR SCIENTIFIC OFFICERS (2, with a first- or second-class honours degree in botany, and well qualified in systematic botany) IN THE DEPARTMENT OF BOTANY, British Museum (Natural History), for research work in the Herbarium and the identification of plants and plant products—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4083/51 (November 15).

SENIOR SCIENTIFIC OFFICERS (4 Chemists and 2 Biologists) in the Forensic Science Laboratories at Birmingham, Bristol and Wakefield—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4085/52 (November 15).

AERONAUTICAL AND MECHANICAL ENGINEERS (Scientific Officer grade) mainly in the Aerodynamics and Structures Departments of the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.596/51A.

AREA SCIENTIST (with a good honours degree and sound experience in fuel technology and coal analysis) in Cannock, Staffs—The Divisional Establishment Officer, National Coal Board, West Midlands Division, Himley Hall, Dudley, Worcs.

ASSISTANT LECTURER (Grade B) IN THE DEPARTMENT OF MATHEMATICS, College of Technology and Commerce—The Director of Education, City Hall, Cardiff.

ASSISTANT TECHNICAL EXAMINING OFFICER (male, temporary) IN THE VICTUALLING DEPARTMENT of the Admiralty—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.60/51A.

CHEMISTS (Scientific Officer grade) at a Ministry of Supply research establishment in the South Midlands area, to specialize in a semiconductor research—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.698/51A.

CHEMISTS, PHYSICISTS, ELECTRICAL ENGINEERS and BIOLOGISTS at the Tropical Testing Establishment, Port Harcourt, Nigeria: SENIOR SCIENTIFIC OFFICER (Ref. A.23/51A) to lead a group of physicists and engineers studying the effects of tropical conditions on service materials and equipment, a SCIENTIFIC OFFICER (Ref. F.686/51A) to work on analytical or biochemical investigations in connexion with deterioration of equipment under tropical conditions, and a SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (Ref. G.349/51A) to study the biological attack on materials and equipment under tropical conditions—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

CIVIL AND MECHANICAL ENGINEERS by the Ministry of Supply in London, Christchurch, Farnborough, Pendine, Salisbury, St. Helens, Malvern, and elsewhere, for design, development, installation and quantity surveying in structural and plant engineering fields, chemical plant, buildings and plant for aerodynamics and armament research, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting E.450/51SA.

ELECTRICAL ENGINEERS and PHYSICISTS (Experimental Officer grade) by the Ministry of Supply at experimental establishments near Southend, Carlisle and in South Wales, for work connected with out-of-door instrumentation: PHYSICISTS or ELECTRICAL ENGINEERS preferably with some knowledge of experimental range technique and procedure—for some posts (Ref. A.262/51A) a knowledge of electronics or mathematics is required, and for others (Ref. A.263/51A) experience in design of electronic apparatus and interest in technical photography is desirable, a PHYSICIST with interest in chemistry (Ref. A.264/51A), and a PHYSICIST with interest in mathematics (Ref. A.261/51A) to examine experimental records obtained during trials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

ELECTRICAL AND ELECTRONIC ENGINEERS by the Ministry of Supply in London, Malvern, Chertsey, Bromley and Sevenoaks, and elsewhere—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.408/51.A.EA.

ENGINEER III by the Ministry of Supply in Lancashire, to assist in the design and supervise the testing and installation of chemical plant, and the temporary erection and testing of individual units—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.607/51A.

LECTURER IN BACTERIOLOGY—The Assistant Registrar, Trinity College, Dublin.

LECTURER (with a good honours degree and conversant with recent research in the chemistry and physics of rubber and similar polymers) IN RUBBER SCIENCE—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

MATHEMATICIANS (Scientific Officer grade) at a Ministry of Supply experimental establishment near Salisbury, for the study of theoretical problems of stability and control and the application of statistics to aircraft testing requirements—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.273/51A.

METALLURGISTS and PHYSICISTS (Scientific Officer grade) as leaders in the X-Ray and Electron Microscope Group in the Metallurgy Division of the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.285/51A.

PASTURE OFFICER, Somaliland Protectorate, to advise the Director of Agriculture and Veterinary Services on technical matters relating to pasture control, to devise and carry out experimental work, etc.—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 27059/259.

PLANT PATHOLOGISTS to form a pool from which a plant pathologist can be detailed or seconded to any Colonial territory to undertake a comparatively short-term investigation of any particular problem as required; when not overseas, the plant pathologists would work at the Institute under the Director on the taxonomy of fungi or plant pathological work of importance to the Colonies—The Director, Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey.

SCIENTIFIC OFFICER IN THE DEPARTMENT OF MARKETING AND EXPORTS, Nigeria, for research work on problems relating to insect infestation of food products, survey work and experimental treatments of infestation—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 27059/297.

SENIOR ASSISTANT (Scientific) at the Atomic Energy Research Establishment, Harwell, to assist in work with high-pressure apparatus, with radioactive materials, with remote handling apparatus, and with high vacuum furnaces—The Ministry of Supply, Est.3.C.1, Room 829.D, Adelphi, London, W.C.2, quoting V.R.703, or the Employment Exchange, Harwell Site Office, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Order No. 185.

SENIOR EXPERIMENTAL OFFICER at the Ministry of Supply London headquarters, for duties concerned with research and development of aircraft textile materials in all forms (fabrics, cordages, ropes, etc.) and involve technical consultations with industry and research organizations, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.697/51A.

SENIOR EXPERIMENTAL OFFICERS, EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS at the Atomic Energy Research Establishment, Harwell: PHYSICISTS (Ref. A.266/51A), SENIOR EXPERIMENTAL OFFICER to take charge of, and EXPERIMENTAL OFFICER to assist in, the industrial applications of radioactive isotopes, involving complex techniques; CHEMICAL ENGINEERS (Ref. F.670/51A), EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS with experience in erection and operation of chemical plant on the pilot or semi-technical scale, or in process development on the laboratory or larger scales; CHEMICAL AND METALLURGICAL ANALYSTS (Ref. F.670/51A.EC), EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS for analytical work (two of the posts are connected with the analysis of heavy metals, rare elements and their alloys); METALLURGISTS (Ref. F.669/51A), EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER with experience in heat treatment, to operate small vacuum melting and precision heat-treatment furnaces; DEVELOPMENT ENGINEERS (Ref. C.565/51A), SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER for development of special types of plant and instruments requiring remote control or for operation under onerous conditions of temperature, pressure and corrosion, for example, pumps, valves, filters, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

SENIOR PLANT PATHOLOGIST (Senior Principal Scientific Officer) at the West African Cocoa Research Institute, Gold Coast—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

STATISTICIAN for work on the investigation of the short-term effects of different controlled thermal conditions on the physiological responses and performance of groups of human beings, and a BIOCHEMIST to carry out work on physiological problems of the adaptation of human beings to hot climates, at the Royal Naval Tropical Research Unit, Singapore—Dr. O. G. Edholm, Medical Research Council Laboratories, Holly Hill, Hampstead, London, N.W.3.

STATISTICIAN IN THE DEPARTMENT OF GENETICS, to work on problems and methods in genetics and biological experimentation—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts.

TEACHER OF TELECOMMUNICATIONS ENGINEERING—The Clerk, Northern Polytechnic, Holloway, London, N.7.